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MARCH, 1925

NEW PROBLEMS OF WESTERN CIVILIZATION[1]

THE CONSERVATION PROBLEM OF THE PAPER AND PULP INDUSTRY

By Professor HENRY S. GRAVES

YALE FOREST SCHOOL

THE extension of the use of paper and pulp products has been one of the extraordinary developments of recent years. There is no single material that plays a more important part in our national life or touches the interests of the individual more closely than paper. The ability to secure paper for books, periodicals and newspapers in large quantities and at reasonable prices has been an important factor in education and in the wide diffusion of information to the general public. Each year over eighty-five hundred new books are published in the United States; the daily and weekly newspapers have a circulation of over forty million; while the circulation of the periodical literature of the country reaches amazing figures. Whatever may be said about the quality of some of the material that is circulated in printed form, the immense volume of literature placed at the disposal of the people must count large in the process of general public education.

It requires only a moment's thought to realize the part played by paper in modern business, not only in the vast correspondence and in essential records, but also in advertising. We are told that a billion and a quarter dollars are expended each year in advertising. Probably not less than 70 to 80 per cent. of this is carried through the medium of paper. Our minds revert naturally to the use of paper for printing, for correspondence, advertising and the like, and

[1] Papers presented before the Section of Social and Economic Sciences of the American Association for the Advancement of Science at the Washington meeting, December, 1924.

the amount of paper for these purposes is enormous, over 3,500,000 tons a year. Yet this is less than half of our total consumption of paper products. More and more paper materials are entering into commerce in a great variety of forms. One of the large uses, that is increasing at a rapid rate, is for paper board, which includes card and paste boards, strong building board and material for fiber boxes and cartons. The total amount of this material used each year exceeds 2,454,000 tons. Then we require annually 1,059,000 tons of wrapping paper; 356,000 tons of fine-grade paper for writing, ledgers and other special purposes; and an additional amount of 1,015,000 tons of paper and pulp products for miscellaneous uses, including blotting, hanging, carbon, copying, tissue, crepe, wax, onion skin, cigarettes, parchment, cartridge, stencil, tar and building papers, artificial silk, insulating material, felts, imitation cork, leatherette, stoppers, etc. Our total requirements each year for paper and pulp products now exceed eight million tons.

The chief factor in this extraordinary development has been the discovery of methods of utilizing wood fiber in the manufacture of paper. In former days paper was made of linen and cotton rags, hemp, esparto grass, straw and a number of other vegetable fibers. The processes of making pulp from wood were introduced soon after the Civil War, but the total amount of paper made from wood was small, as is shown by the fact that in 1870 only about 2,000 cords of wood were used for that purpose. About two decades passed before the use of wood pulp assumed any considerable proportions. During the nineties and subsequently, the industry grew at an extraordinary rate, and the demand for paper products has now so far outstripped the producing industry that we have to import paper and pulp in large quantities from other countries.

The paper and pulp industry to-day ranks high not only because of its magnitude but also because of its importance in producing materials essential in our industrial and domestic life. There are over 725 paper and pulp establishments in the country with a capital exceeding $900,000,000 and employing about 125,000 persons. It is an intensively developed industry requiring a high degree of skill in the technical processes. The manufacture of pulp and paper requires a large amount of power, the industry as a whole using to-day nearly two million horse power, of which about a half is water power.

The paper and pulp industry is a forest industry, for to-day most of the paper and pulp products are derived from wood. The Forest Service estimates that the paper products consumed in one year by the United States required for their manufacture over nine million cords of wood, while we used only 845,000 tons of rags, straw, Manila stock and other non-forest material.

The expansion of the industry was possible only because we have had readily available large quantities of timber of suitable species and quality. Water power we have also had and an abundance of coal for supplemental power. Great mills have been established at favorable power sites at no great distance from the forest supplies. The whole structure of paper-making and paper use now so essential in our national life has been built up about the forest and depends for its continuance upon the forest. The failure to recognize this simple fact years ago has created a situation that may have grave consequences to a portion of the industry. For the most part there has been in the past no consideration of any possible limit to the supplies of timber. Manufacturers did not provide themselves with adequate timber resources and some relied wholly on the wood market. Meanwhile no effort was made to perpetuate the forests, which were exposed to the sweep of destructive fires and were abused in cutting. And we have to-day the picture of an industry overdeveloped from the standpoint of raw material, and with many mills that are permanent in character facing a constant danger of shortage of pulp wood or pulp. Such a condition is economically unsound and it is already causing serious anxiety to the more thoughtful members of the industry.

I do not wish to burden this paper with a discussion of the processes of manufacture of pulp from wood. We should bear in mind, however, that there are four chief methods of reducing wood to pulp. One of these is mechanical and consists of placing wood billets against great revolving stones and literally grinding off the fibers. A large part of the pulp that goes into newsprint paper is made by this process. The other methods are chemical and differ in the chemicals used for breaking down the wood structure and in the details of the appliances and processes in the factory. The so-called sulphite process utilizes bisulphite of lime, the soda process sodium hydroxide, and the sulphate process sulphide and sodium hydroxide. The bulk of the wood pulp is manufactured by the mechanical and sulphite processes. They are adapted to the reduction of such woods as spruce, the true firs and hemlock, whose wood is soft, light, long fibered and easily bleached. The great mills which manufacture newsprint are equipped with appliances for both processes. Newsprint paper is made up of mechanical and sulphite pulp in the ratio of four to one. The former gives body to the paper and the sulphite furnishes the long fibered material for strength. Many of these mills manufacture also, by the sulphite process, a variety of other paper products. The soda process is used chiefly for making book and fine papers, utilizing such woods

as poplar, tulip-tree, bass wood and the gums, while the sulphate process, a comparatively recent development, is used in producing strong wrapping papers and material for board, and is adapted to the hard pines, larches, etc.

The fact of prime significance in the present discussion is that seventy-eight per cent. of all the wood pulp produced in the country is derived from a limited group of trees, namely, the spruces, the true firs and hemlock. It is natural that the manufacturing industry should have been built up in the vicinity of the forests which contained an abundance of these species and which were reasonably near the chief centers of population. The industry has been largely centralized in northern New England and New York, where the best eastern forests of spruce and fir occur, and to a lesser extent near the spruce and hemlock forests of the Lake States. Still smaller bodies of this type of forest occur in the southern Appalachians where also paper plants have been established. At the present time 41 per cent. of the paper and 54 per cent. of the pulp produced in this country comes from New England and New York, and 22 per cent. of the paper and 25 per cent. of the pulp comes from the Lake States.

The adjacent forests are quite inadequate to furnish the wood necessary to supply the great mill capacity in these regions. The forests have been drained down under a destructive system of lumbering that has given little or no consideration to forest replacement. The virgin forests have been mined and at many points are already greatly depleted of the material suited to large quantity operations.

The present situation in New York is especially interesting. It stands first of all states in the production of paper. Over half of the raw material used in the mills now has to be imported from outside the state—chiefly from Canada. Two thirds of the mills own no timber lands and are therefore dependent on the general market for wood and pulp, little of which can be obtained within the state. In 1920 the spruce consumed at the pulp mills of New York, 59 per cent. of which was imported, cost $2.83 per cord more than in other states. A large part of the industry is therefore dependent upon external supplies that are becoming increasingly uncertain as to quantities available and costs. The situation is likely to grow progressively worse, for the private forests are being cut far more rapidly than they are growing, even though some companies are now endeavoring to practice a measure of forestry. There is a considerable body of excellent pulp wood material in the state forests. At present, however, no cutting is allowed on the public properties. Ultimately some measure of relief to the industry will be afforded

through state timber, but the amount made available each year will be carefully regulated and it can not be counted upon to meet more than a part of the needs of the mills.

The state of Maine is somewhat better off, partly because of the extent of the forests and partly because of the conservative and far-sighted policy of the owners. There is a much better balance between the producing industry and the available raw material. Nevertheless Maine is overcutting its forests and already is importing considerable quantities of wood and pulp from Canada. Moreover, Maine has suffered a serious loss through the depredations of the spruce bud worm, which is estimated to have killed no less than 27½ million cords of pulp wood, much of which can not be salvaged. New Hampshire and Vermont are not as well off as Maine, but are in a better situation than New York. In both cases the continuance of their present production depends upon whether in the long run they can rely upon importations from Canada.

The principal material used by the mills of New England and New York is spruce and fir. In the Lake States these species are becoming so rapidly depleted that other species must be the mainstay of the mills using mechanical and sulphite pulp, except so far as they can import raw material from Canada. The situation may be epitomized by the statement that in 1920 some of the Wisconsin mills were transporting wood a distance of 750 miles from Minnesota and 1,000 miles from Canada. The spruce and fir supplies of the Lake States already have been so far dissipated that the home-grown material will render little service to the industry during the long period of regrowth of the forests. Increasingly these mills will probably adapt themselves to hemlock and to jack pine which are suited to the sulphite process of pulp-making. In any case it is an unhealthy industrial situation that is the result of our improvidence in wasting our forest resources and leaving great plants representing enormous investments stranded without home supplies of raw materials.

The same story could be told of other regions in the East where paper and pulp undertakings have been built up about a center of soft-wood timber supply. The serious part of the situation is that the industrial plants are permanent in character. A self-sustained plant, that is, one manufacturing both paper and pulp and equipped to produce both mechanical and chemical pulp, represents a very large investment. A mill having a capacity of 100 tons per day would require a capital investment of about five million dollars, not including forest lands and equipment for lumbering. The problem is not comparable to that of lumber manufacture. Most lumber mills are amortized within a reasonable period and when the sus-

taining bodies of timber are exhausted the operation is transferred to new territory or the business successfully liquidated. The migratory character of the lumber industry is well known and all are familiar with the progressive movement of the centers of production from the east to the Lake States, then to the south and now to the Pacific slope. Because of the rapidly receding supplies of timber we are paying a constantly increased price for lumber and its products. The situation is tersely expressed in the annual freight bill of 250 million dollars that is paid by the public for transporting lumber long distances. The public is vitally interested in having a large production of paper, available at a reasonable price, near the centers of consumption. The local public is deeply concerned in sustaining the industries that are the chief support of permanent communities. From every standpoint, therefore, an eastern paper and pulp industry is of vital importance.

The foregoing discussion is related primarily to the problem of that portion of the paper and pulp industry that under its present organization is dependent upon the spruce-fir-hemlock type of forests, and which is largely centered in the northeastern United States and the Lake States. The problem of the portion of the industry manufacturing paper from the hardwoods by the soda process and the so-called kraft from the heavier softwoods is far less serious. And the mills in the far west have a supply of material suited to the latter process far greater than their present needs.

The immediately urgent problem, that of the production of paper that depends on the mechanical and sulphite process, is being met temporarily by importations from abroad. We import to-day paper, pulp and wood. We export a certain amount of paper and pulp, but it is small compared to our imports. We actually consume over eight million tons of paper. We produce seven million, leaving a balance of a million tons of imported finished product. Only 60 per cent. of the pulp used by our mills is a home product, the balance coming from abroad in the form of pulp or pulp-wood. If we consider the entire amount of paper consumed by the nation, the American forests contributed only 49 per cent. of the raw material.

That is the present situation. Any consideration of a national policy with reference to providing the country with paper products must take into account future as well as present needs. That the requirements will increase is inevitable. An analysis of the situation has recently been made by the United States Forest Service in cooperation with the paper and pulp industry. Necessarily a prediction of this sort is speculative in character. It is confidently believed that we may look forward to a normal increase of the use

of paper that by 1950 will amount to fully thirteen and a half million tons annually. This would require the use of from fifteen to sixteen million cords of wood.

In looking to a solution of this problem we should consider three sources of supply: First, the continuance of foreign material, particularly from Canada; second, the forests of the Pacific slope and Alaska, and, third, the new growth of forests that may be produced in the East by the practice of forestry.

We can undoubtedly count on a certain amount of material from Canada and other countries. In the long run, however, there are elements of uncertainty in regard to the amounts that can be secured. At the present time we are receiving a considerable quantity of pulp and of paper from western Europe, chiefly Norway, Sweden, Finland and Germany. Whether they can continue to export this material in large quantities is questionable. At present their per capita use of paper is far below that in this country. With returning prosperity it is likely to increase and largely to absorb the products of their paper and pulp mills. It is the present policy of Canada to discourage the exportation of pulp-wood, but to build up pulp and paper mills at home. The eastern provinces have placed an embargo upon the exportation of wood from the crown lands and there has been a widespread sentiment in favor of applying the same principle to wood from private lands as well. How far the growth of population and of the industrial use of paper will divert to Canada the pulp that now comes to this country is difficult to predict.

In this connection we should consider whether we should not as a nation be self-sustaining in the production of paper products. It may be argued that the importation of pulp and wood reduces the drain on our forests. On the other hand, there are cogent reasons why we should not be dependent on other nations for paper, at least that used by the press. The materials needed for educational work and for the diffusion of information should be in our own control and there should be an American industry competent to produce these without danger of serious interruption.

During the last five years a number of paper plants have been established near the great forests of the far west. A preliminary study has been made of the available timber suited to sulphite and mechanical pulp. This survey reveals the fact that there are very large quantities of raw material of excellent quality. Moreover, there is an abundance of undeveloped water power within and near these forests. It is estimated that in the three west coast states there are about 400 million cords of pulp wood of species adapted to the mechanical and sulphite processes of manufacture and as

much more suited to making sulphate pulp. About half of the material available for sulphite and mechanical pulp is the western hemlock. Several varieties of spruce and true fir compose the balance. Hemlock and spruce occur in Washington and Oregon and the firs in all three states. While some of this material occurs in separate bodies most of it is mingled with Douglas fir and other species. It happens that the hemlock and the firs have not been prized for lumber on the coast, though the hemlock is more appreciated to-day than a few years ago. The use of the less valuable grades of spruce, hemlock and fir is possible without competing with the lumber industry. On the other hand, they could be logged with the Douglas fir to great advantage. A study in the Douglas fir belt of Washington in 1920 by the government showed that 500,000 cords a year of low-grade material suited to pulp but difficult to sell as lumber could have been taken out in a year in connection with the lumber operations, and in addition about 135,000 cords of timber of good grade but too small for lumber. The timber on the Pacific Coast grows with greater rapidity than in the northeast. Under proper management it would be feasible to support on a permanent basis from the West Coast forests an industry using three and a half million cords of wood of the spruce-fir-hemlock type.

Southeastern Alaska presents a peculiarly favorable field for new developments in paper and pulp production. The forest is wholly coniferous and is composed chiefly of spruce and hemlock. The timber is accessible, the trees of a size to be easily handled, the stumpage prices low and the cost of logging very moderate. There is also an abundance of cheaply developed water power. The largest bodies of timber are in the Tongass National Forest, where the total stand is estimated at about 70 billion board feet. While the timber is serviceable for lumber, the greatest opportunity for industrial use lies in pulp and paper manufacture. The Alaskan forests could provide under forestry methods a permanent supply of at least two million cords per year.

In the Rocky Mountain states there are also bodies of timber suited to pulp manufacture. A great deal of it is adapted primarily to the making of sulphate pulp, but in the northern section, notably in northern and central Idaho and northwestern Montana, there are favorable opportunities for sulphite and mechanical pulp plants. Here one finds spruces, firs and hemlock in abundance and excellent water power. There are in the Rocky Mountains forests probably 80 to 90 million cords of wood suited to the manufacture of newsprint paper. While some of it is scattered and at present inaccessible, large quantities are readily accessible and are available for immediate development.

We have, therefore, in our western forests a supply of pulp wood which from the standpoint of quantity and quality is adequate for our national needs. It has the disadvantage of great distance from the principal centers of consumption and, as already explained, our eastern industry can not be transplanted. The western forests represent a great reserve for future expansion and through the development of the next few years may fill the gap created by the reductions in production that will most certainly take place in the east, due to forest depletion.

We come now to the third source of supply and that is the production of pulp-wood by growth. The permanence and stability of the pulp and paper industry can be assured only by handling the forests under a system of continuous growth of timber. Mining of the forests is bringing us to the end of our eastern supplies. We have not been growing timber in sufficient quantity to take the place of the old trees. Immense areas that have been cut over are only scantily stocked with pulp wood species. A large portion of the areas that are reproducing themselves carry only young trees, so that there will be a long period before they are ready for cutting.

Fortunately the pulp and paper industry is now alive to this problem and steps are being taken by a good many owners to handle their properties with a view to forest replacement. The northeastern forests are now pretty well protected from fire. A certain amount of planting of lands previously devastated is now being undertaken under the stimulus of the cooperative efforts of the state forestry organizations. The methods of cutting still fall short of furnishing the best results in natural reproduction. An examination of the cut-over soft wood lands in the northeast shows a very encouraging amount of new growth coming in. Conditions to-day already warrant, however, a more intensive forestry management of the pulp-wood forests.

Fortunately there is a greater incentive for the practice of forestry for pulp wood than for lumber, because much smaller trees can be utilized for pulp and a shorter period is required to grow merchantable trees. Generally speaking, pulp wood grows at the rate of six to eight tenths of a cord per acre a year. This can be largely enhanced by good forest management. As a rule the growth on the spruce-fir-hemlock lands of the northeast is only about one third of what it might be under intensive forestry. By the application of measures of forestry now quite practicable the growth can be brought to a point that will ultimately give a basis for supplying the full needs of the country for pulp wood. It is believed that the potential annual growth on the spruce-fir-lands of the Middle Atlantic, New England and Lake States will exceed

six million cords. The possible growth in the western forests of this general type is probably over six million cords. In other words, we have sufficient forest land to furnish our needs for sulphite and mechanical pulp if the forests are handled properly.

It has doubtless occurred to you to suggest that the present situation could be relieved by reducing some of the waste that occurs in this industry, as in many others. The greatest loss is through destructive agencies in the forest, *i.e.*, fire, insects and disease. The industry itself is now taking active measures to prevent the deterioration and waste of pulp through fungous disease. It is probable that a larger amount of waste paper could be reused than at present, though already 29 per cent. of all paper produced is reused. Ultimately it may be possible to articulate the paper and lumber industries more closely and to utilize a portion of the sawmill waste. Whether it is feasible or desirable to reduce the use of paper is open to question. Many persons believe that far too much paper is used for advertising, and the average reader would be greatly pleased if the size of newspapers and of many periodicals could be reduced. Generally speaking, this problem is similar to that of the use of lumber or other raw materials. As long as the material can be obtained without serious loss to the country and as long as the use is of service to our convenience and industrial progress, we should seek to provide it.

The possible sources of supply to meet our requirements for paper production enumerated in the foregoing pages will all of them contribute to solve the problem of the paper and pulp industry. The great bodies of timber still standing in the west and the possibilities of producing new crops of timber by growth on lands that will not naturally be used for other than forest purposes place our country in a favorable and independent position for the future.

It would appear inevitable that a considerable readjustment within the industry will take place within a few years. The high costs of bringing wood and pulp from long distances will doubtless cause a reduction in production of sulphite and mechanical pulp in some regions like New York and Pennsylvania, where the remaining timber supply is so much restricted in contrast to the manufacturing capacity.

It is hoped that foreign supplies will continue in quantity and at a cost to make these adjustments gradual, pending the establishment of a proper economic balance as between mill capacity and local supplies of raw material. In any case the question of the practice of forestry is such an important element in the problem that immediate steps should be taken by the industry to bring the forest lands into the best possible condition for tree growth and the

public should cooperate with the industry in a most liberal spirit.

The statistics in this article are largely from the Department Bulletin No. 1241, U. S. Department of Agriculture, 1924.

POPULATION PROBLEMS OF SOUTH AMERICA

By WILLIAM A. REID

General Observations

It has been said that of the billion and a half and more people who dwell upon this earth of ours a larger number are evincing migratory instincts than at any former period. Every one knows that the abnormal conditions of the nations during the past decade have increased the desire to wander. This spirit is reflected in countries of sparse population as well as in the most densely settled nations of the world. Australia, with fewer people per square mile than any of the continents, finds some of her citizens developing wandering tendencies. A number from the Antipodes actually emigrated and colonized in Paraguay in the heart of South America. As a reversal of the movement, a group of fifty discouraged Argentine families removed to Australia to start life, as they believed, under more propitious circumstances. Canada, with millions fewer people than the dominion needs, is forced to part with numbers of her best workers, who sail for South America. The United States, more willingly, of course, witnesses scores of western planters and stockmen moving to lands of the southern continent. Overpopulated Italy gladly contributes to help people the newer regions of the earth; and the former Perene colony in eastern Peru illustrates the attempt to place Italians in large numbers on the borders of semi-civilization. Japan encourages her citizens to emigrate, and from that country a rather steady flow of natives is moving to South America in general and to Brazil in particular.

Railways of all the continents are moving a vast number of passengers, many of whom belong to emigrant classes. It is not unusual to find transcontinental trains in the United States well filled, often crowded; trans-Canadian, trans-Siberian, trans-Australian and trans-Andean railway services are experiencing active passenger traffic. Suez and Panama report that the movement of peoples in increasing. Eastward through Suez thousands of Europeans, especially Britons, are migrating from congested areas to the sparsely settled Australia and New Zealand, while Panama witnesses Europeans passing westward to South or Central America.

Indeed travel, migration, human movement—call it what you will—is active everywhere.

When I think of this great movement—this restlessness of peoples of all climes—I am reminded of a scene, miniature in comparison, that once came before me. It was that of herds of cattle, camels, sheep and goats wandering aimlessly over parched regions of the earth in northern India. Thirst and hunger had curbed the spirit of animosity that usually prevails when animals of different classes are thrown together, and, suffering and bellowing, they tramped onward—somewhere—anywhere—more docile, less bellicose.

So as people of all races migrate here, there, yonder, about the world, serious minds are asking questions. Will this meeting and commingling of human beings, as they find new homes and possibly more promising futures, bring tranquility? Will it in time render people more docile—less militant? Will composite populations be endowed with greater tolerance and will the western world with its abundant spaces be the haven of hope and work and peace?

Let us look at a few population problems of the vast South American continent—a continent not yet peopled, and, indeed, a new world toward which thousands are turning with wistful eyes. In doing so we must remember that South America is a continent—not a country. One might really be justified in attempting a discussion of the population problems of a country, but could the justification be extended to such a gigantic task as that of the population of a continent? The answer calls for a book, not a brief paper. On the other hand, every one knows that South America—a cluster of independent nations—has certain things in common. All the republics are underpopulated; all of them attained independence about the same time; all are storehouses of diversified raw materials; all extend the hand of welcome to the proper kind of immigrant; all the conquering peoples speak a Latin tongue, and all the republics are obtaining much of that vitalizing influence—capital—from other continents.

Overpopulated and Underpopulated Areas

In South America the same instincts of the North American are to be observed in respect to urban and rural populations. Natives of the several countries as well as immigrants have the tendency to congest in larger cities. In a government investigation of this condition conducted in Buenos Aires it was found that in certain districts there were from three to twenty families living in one house and as many as nine persons sleeping in the same room. Again, the province of Buenos Aires is the home of nearly half the people of the republic. In the five larger cities more than two million people have their homes.

During the past 50 years there have settled in Argentina more than 2,000,000 Italians, about 1,200,000 Spaniards, more than 200,000 French, 50,000 English, 70,000 Hungarians, 50,000 Germans, 30,000 Swiss, 22,000 Belgians and smaller numbers of other nationalities. The latter include several thousand from North America. Of the 178,000 emigrants who left Italy last year, about half of the number went to Argentina.

In the 12 years ending in 1919, Italy sent 166,000 settlers to Brazil. The Italian population of Brazil, including children born of Italian parents, is estimated at considerably more than 2,000,000. In the state of Sao Paulo more than 1,000,000 out of a population of 3,000,000 are Italians. More than one half of the inhabitants of the city of Sao Paulo are of Italian blood.

Overcrowding in Chile is reflected in recent investigations by the Federal Labor Bureau. It was shown that 37,967 persons were living in 712 tenement houses. The average number of persons per room in Valparaiso was 3; Antofagasta 2.69; La Serena 3.33; Concepcion 2.42. The report further shows that of the 23 provinces of Chile, Valparaiso, the smallest, is the most densely populated, having 200 persons per square mile. The province of Santiago comes second, with 100 persons per square mile.

Chile has not received immigrants on a large scale. For ten years prior to 1914 the arrivals are shown to have been not more than 2,500 per year; and since the World War the European has not come to Chile in numbers. In traveling about the country one often hears the slogan, "Chile for the Chileans," which seems to indicate that the national spirit considers too many immigrants more detrimental than profitable. Still there is room in Chile for millions more than she possesses if they come gradually and are assimilated. But they can not colonize in the north—in the desert—and the several German colonization schemes that were tried in the extreme south were not a success.

From immigration statistics issued by the Oficina Internacional del Trabajo it appears that immigrants arriving in Chile at present are coming in larger proportion from countries of northern Europe than is true of other South American countries. France and Germany are credited with 19 per cent. each, and Spain and England sent 17 per cent. each of arrivals. Of the remainder, Italy supplied 13 per cent., the Netherlands 7 per cent., Belgium 4 per cent. and others 4 per cent.

Uruguay, with a population of 1,603,000, increased its people during 1923 by about 38,000. There was an excess of births over deaths of 22,000, while immigration amounted to 16,000. These figures are official estimates, as Uruguay has not taken an actual census enumeration for some years.

Bolivian population, still under 3,000,000, is huddled together on a parallelogram half a hundred miles wide and 400 miles long. The great majority, of Indian origin, are mine workers, primitive agriculturists, tenders of herds of sheep, goats, alpacas, vacunas and llamas. The people cling to highlands and leave the lowlands, stretching for hundreds of miles from Cochabamba, Sucre, the Yungas Valley to the Paraguay River, to the few human beings who spend their lives where nature is prodigal and progress little known. One of the Bolivian problems, therefore, is to settle the vast eastern plains; and at least two activities foreshadow the inflow of new peoples—the Bolivian government's railroad building scheme and the development of petroleum in the Santa Cruz region by a great American corporation.

Germans have settled in every South American country. In Brazil, Argentina, Chile, Bolivia and elsewhere they own large plantations, banking interests, commission houses, etc. In southern Brazil it is estimated that there are more than 200,000 Germans.

"What are your population problems?" I asked an Ecuador official in Guayaquil. "Problems—problems," said he, "we have no problems. Oh, yes, it is difficult for our producers to market their crops. If we had more railroads and highways—if we had modern communication from Quito and Riobamba into our eastern plains, you would see more ships in Guayaquil and more immigrants seeking homes in Ecuador." Later, I chanced to hear expressions of another prominent Ecuadorean; he said: ". . . We lack population. We need capital, workers, railroads and highways, machines and modern tools, to undertake farming and mining on a large scale. We need engineers, geologists, men of action and enterprise to import capital and labor, without which the people of Ecuador will indeed remain relatively behind in the race."

I inquired of a Colombian diplomat as to the outlook for the settler in his country.

"Our problem is largely one of improving transportation, of connecting Colombia's numerous railroads. Some work of this nature is now in progress, and highways are being given further attention. We have established airplane service, and the trip from the Caribbean coast to Bogota consumes only eight hours instead of eight days or longer as in the past. As transportation facilities gradually extend we can place judiciously a larger number of immigrants. Colombia's population of 6,300,000 is only 13 persons per square mile and is small compared to our area of productive lands."

The Agrarian Question

Sustenance for the human family, of course, comes from the earth, and South American countries are regions in which man has

made little more than a good beginning in modernized or intensified tilling of the soil, working the mine, tapping the forest; although stock-raising and wool production have passed the experimental stage. But the word "intensive" can not be applied to agricultural and industrial South America in a similar sense to its significance when we speak of Belgium, Holland or Japan.

First of all problems after government is land. There is land, productive land everywhere for the rich man, but unfortunately and truly there is little land available for the man without means. That, to a greater or lesser extent, has been the condition since the coming of Europeans. In no country of South America is the outlook for land ownership more than fairly satisfactory for the poor man. For years public-spirited citizens and some legislators have sought to solve the agrarian problem; but they have found that they, themselves, are often the offenders. So vast are hundreds of estates that have descended from family to family for generations that they are mentioned by square leagues rather than by hectares and acres. Argentina furnishes an illustration of this condition. In the Pampa region, 30 per cent. of the land is owned by fewer than 100 persons, whose average holdings are 112,000 acres; in Misiones, one of the rich agricultural provinces, 42 persons, averaging 135,000 acres each, own 97 per cent. of the land; in the far south similar conditions prevail, where more than 50 per cent. of the land is held by 36 individuals.

Argentina, by reason of her greater railway mileage and large immigration, furnishes a suggestion of what might be accomplished were it possible for the immigrant to obtain a small piece of land at reasonable cost and on the long-term payment plan. Land on a connected system of railways or along river courses is not available at what might be termed a reasonable cost. On the other hand, there are abundant cattle and agricultural areas in the distant or inaccessible parts of all the republics. An illustration is that offered by Paraguay, where a few years ago an American corporation acquired a million or more acres of productive land at the insignificant price of 65 cents per acre. The work of building a railroad from the Paraguay River to and through the property was among the first activities undertaken, for without a railroad or highway outlet the interior lands were useless. Now, railroad-building calls for capital. An individual with small means might acquire lands in these outlying districts, but the chances for success would be very small without a modern means of dispatching his products to outside markets.

Some of the leading railway systems of the eastern republics have been instrumental in placing immigrants along their lines by

providing small farms and granting the immigrant a series of years in which to work and pay for the property. The Central Argentine Railroad furnishes an example, where 20,000 foreigners were settled on or near its lines during a recent year. Other railroads are doing the same thing, an activity that promises good results.

Tropical Inertia

The equatorial belt extending around the world casts its spell of inertia for three thousand miles across South America. Thus, vast areas of Brazil, Venezuela, Colombia, Ecuador, Peru, Bolivia, Paraguay and the Guianas—more than half the political divisions of the continent—are included within the hot or warm zone. In parts of these areas man has avoided making a permanent home. To be sure, in these hot lands there are not only settlements but also towns and cities where the native population has been augmented by the coming of people from cooler areas of the several countries as well as from lands over the seas.

Those of us who are familiar with tropical lands of the east and with tropical lands of the west are aware of the prevailing lethargy —there is the same disinclination to manual toil—to any physical exertion. But the east with its teeming millions has had for centuries certain advantages over the west. One of these has been the inflow of Europeans who have directed the operation of natives. In other words, the people coming from northern Europe, possessed of energy and progressive ideas, often backed by capital, exerted a stimulating influence on the native population and also caused a limited dissemination of sanitary knowledge. The second advantage, from a business and health point of view, is that the laborer of the east is not burdened with clothing. A loin cloth is all that is worn by the Eastern tropical worker, which gives him the advantage of better health than the tropical laborer of South America, where even the lowest class wears at least the trousers of civilized man. Tropical rains and a burning sun have limited effect on the oil-anointed body of the Oriental worker; while these same elements play no minor part in causing sickness of the South American tropical laborer, because when his clothing becomes wet, it is not changed but dries on the body. The point I would make is that high mortality among tropical workers in South America is a condition that can be improved by sanitation and education. That it is possible to surround laborers and their families in tropical jungles with health safeguards has been demonstrated again and again. Conspicuous examples were the conservation of life of the laboring masses at Panama; of those who finally succeeded in building a railway around the rapids of the Madeira River in Brazil, and the

measures that changed Rio de Janeiro, Santos, Guayaquil and other cities from high mortality to healthful places in which to live.

Brazil, so large and so varied in land, soil and climatic conditions and with only about ten persons per square mile, would at first thought seem to offer unlimited opportunities for the immigrant. But Brazil, like smaller countries, is not prepared to receive immigrants faster than they can be assimilated. There are parts of Brazil where human beings in numbers have been so swallowed or overwhelmed by the forests that few escaped. For instance, a large party of dissatisfied workers on the Mamore-Madeira Railroad, in the early stages of that enterprise, attempted to raft and boat themselves back to civilization. To leave the jungle by a trackless land route would have been even more hazardous than the one adopted. Yet we are told that a small percentage of those who essayed to escape the Mamore region actually reached Para. They died of starvation, fevers and exposure.

The struggle against nature in this instance reflects conditions that prevail to-day in tropical South America. The rich jungle lands are there, but it requires capital and, as a rule, operations on a large scale rather than individual effort to combat primitive nature. Come with me to another interior region of Brazil. Imagine you are on the Alto Parana River at the Falls of Guayra, which stand at the head of steam navigation. Twenty-seven miles of railroad connects the lower and upper waters of this artery of trade. For several hundred miles up and down stream one finds here and there a settlement, with from one to two shacks to a hamlet of eight or ten "habitaciones." While most of the land is owned by absent landlords, natives and a few foreigners are battling to keep from being overgrown by rank tropical growth. These people are maté workers, lumbermen, tobacco growers. "How long have you lived here and why do you stay?" I asked an Italian who operated a diminutive trading post at Pirey, one of the settlements to which I refer. "I have been here three years," he replied. "I am married to a Paraguayan, and we like this country life better than Asuncion. Some day I will go back to Italy, but not until we make money here buying and selling things. It is too quiet here for most people who come from cities. Some immigrants are sent here by the government, but usually they go down the river to Posades or Corrientes. They want to be where there is more life and more business. They are not tropical pioneers."

Inadequate Transportation Facilities

The marketing of products that have been raised, mined or produced has always been a serious problem in South America. The

countries that possess the greatest railway facilities, like Argentina, Brazil, Uruguay and Chile, have, of course, profited by modern traffic facilities, but these have been inadequate. Fluvial navigation, especially in eastern and northern parts of the continent, afforded a means for transporting commodities to the growing settlements on the coast or on rivers that reached the seaports. Engineers, you know, abhor hills and mountains and favor the course of rivers in selecting the routes that railroad constructors are to follow. Capital dictates the general region to be tapped, but the engineer actually selects the route of least resistance—the route of the stream or river. What is the result? Vast and virgin regions have not been tapped by transportation. And the region where there is neither river nor railway service to the exterior the settler has, as a rule, largely avoided. Let me illustrate.

Santa Cruz de la Sierra in Bolivia, situated near the geographic heart of South America, is about 500 miles from a railway on the west and a like distance from the navigable Paraguay on the east. The sparse population raises by primitive methods sugar, rice, fruits and other foods. Those not needed locally are sent toward the four cardinal points by man's most primitive carrier—his own back and on mules and donkeys. It is true that a motor car—the Ford—did actually arrive at this secluded place, but the wretchedness of the trail leading from the Paraguay River so wore its parts that the car never was in form to be driven back to the Paraguay.

Housing and Health

Fewer palatial residences for the rich man and more livable homes for the poor man are conditions that need adjustment in all South American countries. Look at Copacabana, in Rio de Janeiro; Plaza San Martin, in Buenos Aires; Vina del Mar, in Chile; Plaza Colon, in Lima, and a hundred other places. Then turn your attention to the thatched cot and the mud-built hut with the ground floor to be found in populated regions of any part of South America. Look at the people, for instance, who dwell in rural Bolivia, Paraguay, Venezuela or northern Argentina. Many of them, born and bred amid squalor and poverty, know of no higher form of living. Oftentimes, however, the rich landowner or the corporation that profits by the labor of these downtrodden humans could at very trifling expense, comparatively speaking, make laborers more comfortable, conserve their health and thereby insure a steadier flow of workers to a given enterprise.

Among the most conspicuous efforts to house and care for the laborer that it has been my privilege to examine are the new workmen's homes in Buenos Aires, in Santiago, those of the Chile Ex-

ploration Company at Chuchicamata, and the new homes in the region of Santa Marta, Colombia. Among the improvements at the last two places, modern sanitation, health safeguards, hospitals, trained nurses, surgeons and other remedial agencies have resulted in saving thousands of lives.

Those who are unfamiliar with the progress of modern and medical education in the southern continent will be surprised should they read a book entitled "South America from a Surgeon's Point of View," by Dr. Franklin H. Martin. It shows that a few scattered hospitals have grown to many such institutions and medical courses are liberally provided, thus permitting those of modest means to pursue the study of medicine. In former years it was mostly the sons of favored families who could really equip themselves as physicians and surgeons by study in Europe. To-day the South American medical schools, according to Dr. William J. Mayo, are the "equal in equipment and methods of theoretic teaching of any in the world." The progress in sanitation in most of the countries has been marked, and the recent visit of the United States Public Health Service officials to South American countries and the measures of international sanitary cooperation entered into between South American and United States officials foreshadows a gradually lessening mortality.

Conclusion

Varied activities for conserving population are to be noted in each South American country, but to enumerate them would be too lengthy for this paper. I refer to only a few illustrative cases: the new land settlement service of Brazil; Uruguay's school for training municipal nurses and efforts to attract young women from the best families; Argentina's national housing commission and its work in saving babies and in providing better homes for laboring classes; Chile's new housing commission which has stimulated life conservation; in Colombia, the lessons taught by foreign capital in caring for laborers and their families, which lessons are being extended by national authorities; the sanitation and modernization of Guayaquil, and at least a change of attitude toward the laborer by at least some of the landed proprietors; the introduction of modern sanitary appliances and underground sewerage in the Bolivian capital; the awakening in Venezuela for modern highways and the actual building of a number of miles of such roads; Peru's new laws in behalf of the laboring classes and explicit stipulations to employers of labor, and in Paraguay the exemption from all taxes for five years on homes constructed by the poorer classes.

Will tropical inertia ever be eradicated? Perhaps not, but when we look at activities and accomplishments in Java, the Straits Set-

tlements, Ceylon, Cuba, Panama and scores of other sun-parched and rain-drenched lands, who can doubt that the hot regions of South America may not one day become as livable, as productive and as profitable? For example, suppose some rubber corporation would devote as much capital to Amazonia as one American company did in Sumatra. Granted workers are available, is there doubt of practical and satisfactory results?

Will isolation disappear? Certainly, but slowly. Look at the factors working on the problem of isolation. There is the radio, the telephone, the highway, the motor car, the village "movie," the railway, the steamboat, the rural mail delivery, as well as other influences that carry life interests to even the most secluded estancia. Select any one of the ten South American countries and we find all the above-mentioned forces being gradually extended.

These factors of inertia and isolation are being further relieved by what some persons aptly term "mechanical civilization." This really means the partial removal of manual labor from hundreds of employments, and the application of electrical, steam and oil energy; it signifies, for instance, the employment of the giant harvester and thresher in place of the hand cradle and the sickle. Labor-saving devices serve equally well in hot lands and in isolated regions. So, in considering some of the problems I have found that "mechanical civilization" has made a good beginning and I confidently expect to see life, conditions and production radically changed and strengthened within comparatively few years.

Crowded Europe, with 476 people per square mile, and more crowded Asia, with about double that number of persons living in similar areas, look to the new lands of the west for homes and fields of labor. South America with only eight persons per square mile has ample space for millions of additional human beings. The several nations bid the newcomer welcome. But this coming of people must be on a reasonable basis. The current should not be too rapid and those who do come must possess a spirit akin to that of the forty-niners who crossed the plains of the United States, banishing the buffalo, stocking the ranch and plowing the furrow. It is just such sturdy pioneers that South American countries need—those inured to toil, and particularly to toil in the open country.

When a former president of a South American nation is engaged as an ordinary clerk; when a son of a South American admiral is working his way through an American college; when the son of a South American millionaire is serving under tropical sun day after day as an irrigation engineer; when a former cabinet official is pleading for a clerkship to keep the wolf from the door, and when these few cases are typical of thousands, we may believe that so-

called aristocracy is passing through evolution, just as are the land barons and social butterflies of Great Britain. And when intellectual workers are joining hands with manual laborers and these two forces marching phalanx-like, guided by reason and not by the rashness of the student, it must be realized that the days of the hidalgo are never to return. I am reminded of an ancient custom in China, where once a year the ruler, in order to dignify labor, put his hands to the plow and turned the furrow; and of Captain John Smith, who ordered that those too proud to work should not eat; of the remarks in our day of Sir Philip Gibbs, who says: "Departed are the privileges of a wealthy and leisured crowd—gone forever is the age-long allegiance to caste, dividing class from class." South Americans, I believe, are appreciating the dignity of labor to a greater degree than ever before, and are realizing that their problems can not be solved without the inflow of new peoples. Wise heads therefore plead for a fair deal for the newcomer, for a piece of land for him to cultivate, a modest but comfortable home; in other words, welfare and contentment—for a contented middle class in the lifeblood of nations.

RACIAL DIFFERENCES IN MENTAL ABILITY

By Dr. BERTHA M. LUCKEY
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In a city containing such a large percentage of foreign-born adults as Cleveland, and in a job dealing entirely with the study of human reactions, one can not work very long without coming up squarely against the problem, "What rôle does nationality play in the mental development of children?" or "Does the development of intelligence depend upon the race from which the individual has come?"

As in any school system, the attempt is here made to keep the progress in the different buildings uniform, so that children can move between buildings without loss of time or inconvenience. This uniformity is often very difficult to obtain; teachers in one building may slave to get the same results that are obtained with ease in another place. The question at once arises, "What is the cause—environment or heredity?" As a partial answer to this question, about four years ago a study was made by Mrs. Abrams, using a group test to study children in the first grades.

It was found that in the schools chosen tests showed the following rank: American, Jewish, Hungarian, Bohemian, Colored, Polish and Italian in order of success in the test. While the different

nationalities coming from the separate schools were grouped together there were variations between the buildings. The Jewish children tested brighter than the average child in some districts and less than the average in others.

The conditions were these: In the latter districts the housing conditions were very undesirable; as a result just as soon as a family could amass enough money to move or showed an interest in better surroundings, they moved out to the better districts. Consequently only the dregs of the Jewish group were left behind in the schools where the children showed such poor results. In these districts, there were a large number of "charity families" and homes with defective children.

When abroad, I had the pleasure of working in a very cosmopolitan laboratory, in which fifteen different nationalities were represented at the time. In that group was a Polish countess, through whom we became acquainted with her fellow-countrymen, who impressed us with their high degree of intelligence and ability. Imagine my surprise to find in Cleveland the general feeling that the Polish people were a dull race, that they did not learn well in our public schools, etc. This fact, coupled with another fact, namely, that the Bohemian group was regarded as having much higher ability, was very intriguing. Here again, the laws of selection may have played a rôle.

Our first Polish groups were brought into Cleveland by the owners of the steel mills. The officers went to Europe and brought over boatloads, often moving whole villages and transporting them bodily to their present locality. In these places they have stayed, laboring hard, putting up with adverse working conditions, clinging to customs and homes, manifesting little disposition to change their conditions. On the other hand, among the Bohemians were a large number of social and political refugees; people who fled from conditions that were undesirable and who are seeking social freedom.

We will now see if the results of the clinic give any clue to this difference in the groups. For the last five years, a careful record has been kept of the nationality of the parents of the children tested by the clinic. The present study is based on the records for the last two years. During that time over 14,000 examinations have been made. As at least a year must elapse before a child is retested there are as many separate children as examinations made. These children were all carefully tested by skilled psychologists. Every attempt was made to eliminate any adverse factors due to timidity or lack of understanding. Failures due to language and personality of the child and of the psychologist were carefully noted. Cases where the results might be challenged were not recorded here. The child's nationality was based on the nationality of the father and

the language spoken at the home. For that reason you will find Jewish used in this study rather than Russian and Polish Jews. There were two types of colored, those coming up from the south and those who have always lived in the north. Since the war and during it, Cleveland had a large influx of southern Negroes. The larger percentage of the colored children examined were from the south.

Boys and girls were grouped together for this study, although there were 25 per cent. more boys than girls. This factor together with that of chronological age affected all groups alike. The children studied ranged in age from four to twenty-one years; the largest group tested was between five and eight years of age. There were very few children below five or above sixteen.

In some of the nationalities, the number of individuals studied were so small that it was felt that chance would make results valueless. As a result no groups are mentioned here except those in which two hundred or more children were examined. These groups are arranged in order of number of children tested: American, Italian, Polish, Negro, Hungarian, German, Jewish, Czecho-Slav, Slavish (Jugo) and Slovenian. (On comparing it with the chart taken from a study made in Cleveland in 1921, it is found that the number tested is not always the group with the largest percentage of children in the Cleveland school.) This study as can be seen is different from the usual study on correlation of nationality and mental ability.

No selection based on nationality was made in picking the children to be examined. The data was taken from those referred to the clinic for other reasons. A child is brought to the clinic because he stands out from the regular group either because of his unusual slowness or very great ability in school. So the present curves suffer from a marked askewness, especially in the relation of the percentage of subnormal to normal children tested. In order that there be a common means of comparison the Terman I. Q. was used and we have the following results.

Group	Below 25	25–50	50–65	65–80	80–90	90–110	110–120	120–140	Over 140	Total
American	0	41	224	639	567	851	351	261	30	2,964
Italian	0	28	287	732	435	379	6	4	0	1,881
Polish	0	40	397	654	331	236	21	2	0	1,681
Negro	0	43	413	583	320	196	9	10	0	1,575
Hungarian	0	19	133	310	224	267	13	9	1	976
German	0	10	125	247	165	207	41	24	3	822
Jewish	0	16	74	145	149	234	100	88	9	815
Bohemian	0	8	58	139	133	125	27	8	0	498
Slavish (Jugo)	0	17	114	168	88	75	7	3	0	472
Slovenian	0	5	67	131	62	73	7	3	0	348

As can be seen from the table the Jewish group, although only one half as many were examined as the Polish group, had over forty times as many children who would be called bright; they had, on the other hand, less than one fourth as many children who were so seriously retarded that regular school work could not be given them.

Since the number of children tested in each racial group are not the same the comparisons below are based on the percentage of children tested and not the number of cases.

(1) All the curves show a certain amount of likeness between the groups—small numbers of cases at each extreme and an askewness due to the fact that few normal children in comparison to those who vary from the average are tested by the clinic.

(2) The percentage of children classed as borderline or below in each group would be as follows (the figures after the names of the group represent the total percentages of those whose I. Q. was below .80): Negroes—65 per cent., Polish—65 per cent., Slavish—63 per cent., Slovenian—58 per cent., Italian—55 per cent., Hungarian—47 per cent., German—46 per cent., Bohemian—41 per cent., American—30 per cent., Jewish—29 per cent.

(3) The groups arranged according to those having a large percentage of bright or unusually bright children (I. Q.'s above 110) examined would be as follows: Jewish—24 per cent., American—22 per cent., German—8 per cent., Bohemian—6 per cent., Slovenian—3 per cent., Hungarian—2 per cent., Slavish—2 per cent., Polish—1 per cent., Negro—1 per cent., Italian—½ per cent.

(4) In spite of the above ranking of children below borderline it was noted in the case of children classed as "Imbecile" the Jewish and American groups had as many as any other one; in fact, more than the Negro and Slovenian groups.

As these studies have been based on local conditions, no sweeping statements can be made. They give, however, a rather interesting glimpse on the laws of selection, both artificial and natural.

THE COMPARISON OF RACES

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THIS paper does not presume to cover with any sort of completeness either its subject or the related subject of intelligence tests in their application to the members of different races or the questions of racial superiority and inferiority which in Japan, in South Africa and in India, as well as in our own country, are so deeply

stirring the minds of men to-day. Nor can I make any pretension to scientific or erudite authority; my only warrant for expressing a judgment in such matters is an experience for the past six years and a half at Hampton Normal and Agricultural Institute, a school for Negroes and Indians at Hampton, Virginia, established in 1868 by General S. C. Armstrong, carried forward after his death by Dr. H. B. Frissell, and most famous, perhaps, as the institute where Dr. Booker T. Washington, of Tuskegee, received his training. My single present purpose is to utter a brief *caveat* against the loose, wild, hasty, clearly unscientific generalizations which have confused the thinking even of intelligent and scholarly persons upon these matters. In few fields of human inquiry, I venture to believe, has there been such unrestrained darkening of counsel by words without *knowledge*.

One might have supposed that the World War would have put an end to the intellectual arrogance not only of Houston Stewart Chamberlain, but also of his disciples and the whole cult of "Nordic" self-laudation. But it continues; and one sees even in such titles as "The Passing of the Great Race" and "The Rising Tide of Color" the not over-subtle suggestion that the progress of the peoples of the earth who do not happen to have pale skins must bring overwhelming disaster and perhaps annihilation to those who do happen to have pale skins. The innate inferiority of the darker races is commonly taken for granted; when statistics are gathered and used, they are sometimes gathered carelessly and used not quite justly; and when the powers of a despised race are under discussion there is often an undue freedom in the assertion of the universal negative, with a surprising neglect of the logical axiom that only a single contrary instance is needed for the refutation of such argument.

To come down to specific facts, a recent and widely discussed case of this sort has been the examination of the "intelligence," so-called, of the drafted men in the Army of the United States during the World War, and the inferences drawn from the resulting figures. The Alpha test, given to the literate soldiers, covered, in the data which were gathered for study, 103,500 white men and 19,000 Negroes. On the basis of these data, it was concluded that the average mental age of the white drafted men was 13.1 years, and the average mental age of the Negroes was 10.4.

But it should be remarked that these tests were commonly given, so far as we know, *by white men* to white and black soldiers, not by black men to either white or black soldiers. When you have a white officer examining a black private there is a variable factor of fear, hesitation and unreported misunderstanding for which some

allowance should be made, and for which, so far as I know, no allowance has ever yet been made. What is called in logic "the universe of discourse" of the black soldier and his white examiner must frequently have been entirely different. The black man might easily fail to grasp what the white man was asking him. A few years ago, when visiting the Indian reservations in South Dakota, I found that Indian boys and girls applying for admission to Hampton Institute were invariably stumped by the question in the application blank, "Have you any *physical defect?*" They could talk English, but not that kind of English: those two words meant nothing to them. One suspects that a similar gap between the language of the white psychologist and the Negro or foreign-born private soldier must have occurred much oftener than was ever revealed.

Furthermore, it has been pointed out by Dr. Horace M. Bond,[1] the median scores of the white recruits from certain southern states were below those of the Negro recruits from certain northern states. His table of comparison follows:

Median Scores

Whites		*Negroes*	
Mississippi	41.25	Pennsylvania	42.00
Kentucky	41.50	New York	45.02
Arkansas	41.55	Illinois	47.35
Georgia	42.12	Ohio	49.50

The simple, natural, obvious conclusion to be drawn from such figures is the one to which Dr. Bagley, of Columbia, and many other experts have come: that the army tests revealed not so much native, inherent intellectual alertness or ability as general knowledge based upon schooling and home backgrounds. Inevitably the Negro soldier whose school experience had covered only three, four or five months in the year would, as a rule, make a poorer showing than the white soldier who had gone to school for more months in the year and probably for more years of his childhood. But there is no material here for dogmatic statements about the comparative *inborn* ability of the two groups.

With this view accords the conclusion of Miss Ada H. Ashitt,[2] after studying several hundred children of different races in a district of New York City. She writes: "No study of racial differences which fails to take into consideration the social status of the group tested can be considered valid." In like fashion, Dr. Thomas R. Garth has written:

[1] *Opportunity*, July, 1924: "What the army tests measured."

[2] "On the need for caution in establishing race norms," *Journal of Applied Psychology*, Vol. V, No. 2. Quoted by Dr. Bond.

The elements in a study of racial mental similarities or differences must be these: (1) Two so-called races, R1 and R2; (2) an equal amount of educational opportunity E, which should include social pressure and racial patterns of thought; and (3) psychological tests D, *within the grasp of both racial groups* [italics mine]. We should have as a result of our experiment R1ED equal to, greater than or less than R2ED. In this experiment the only unknown elements should be R1 and R2. If E could be made equal, the experiment could be worked.[3]

Dr. Garth might well have added, "and if D could be made *equally comprehensible* to R1 and to R2." But of course this can never be surely accomplished, any more than the total educational experience of two individuals of differing race can be made identical. The careful investigator will simply recognize these two variables and make whatever allowance for them seems just.

A similar attitude is shown by Dagne Sunne, of Newcomb College, in a recent study, published in *School and Society*,[4] comparing white and Negro children on the basis of verbal and non-verbal tests. The Myers Mental Measure and the National Intelligence Tests were used. It is remarked by this observer that:

The lower performance level of the Negro pupils must not obscure these facts: Individuals of both racial groups are found among the highest and the lowest three per cent. at every age level; the highest score in National Intelligence tests was reached by a white girl and the highest score in the Myers Mental Measure by a Negro girl and the third highest by a Negro boy; 1.2 per cent. of the white and .3 per cent. of the Negro children attained scores above 80 on the Myers Mental Measure, and 1.6 per cent. of the white children obtained scores higher than the upper limit of the Negro on the National Intelligence test. "This difference in the percentage of the two groups at the upper limit may be significant but it is small."

And, finally:

It is difficult to determine how much racial differences and how much differences in school training and social conditions contribute to the divergence in test results. For an accurate determination of facts, it will be necessary to study the development of the same groups of white and Negro children for consecutive years in physical and mental growth and in school achievement.

In connection with this question of the comparative ability of white and Negro pupils, some statistics which were gathered at Hampton Institute several years ago may be of interest and value. In the Record Office, where the previous history as well as the school and later record of each student is kept, seven degrees of color are distinguished—black, dark brown, brown, light brown, light, very light (ordinarily those who would be known as Negroes only by their hair or other features, not by their color), and with "no trace"

[3] "White, Indian and Negro work curves," *Journal of Applied Psychology*, Vol. 1, No. 1.

[4] Vol. XIX, No. 486, pp. 469–472 (April, 1924).

(indistinguishable from white persons). In the investigation under consideration the classification of students according to color was made by two observers for the sake of securing a higher degree of uniformity.

The number of Negroes entering the institute in all classes for whom complexion was so recorded, from 1901 to 1910, was 2,404 (of whom 1,468 were males, 936 females). The color distribution was as follows:

Color	*Number*	*Percentage*
Black	39	1.6
Dark Brown	873	36.3
Brown	519	21.6
Light Brown	587	24.4
Light	304	12.6
Very light	64	2.7
No trace	18	0.7

The comment was made at the time when these figuers were collected that "the present high percentage of mulattoes is probably due to the fact that the mulattoes have been more favored as regards education, both by the white people and by the colored people." In the older days, the house servants and their children would be apt to have the attention and interest of their masters and mistresses or employers, and in general to be stimulated by the example and influence of white people to learn to read and write and cultivate their minds. It was natural that a good many in this group should be of mixed blood.

The scholastic records for these students, classified by color, show that on the whole there is little difference between the different color-groups. Such variations as are found seem, as has been said, quite as likely to be due to previous schooling as to any other cause. It can not be affirmed that any significant conclusion can be drawn as to the influence of either white or Negro blood upon mentality.

The color-classification of the twenty-one[5] best scholars (salutatorian and valedictorian) of the graduating classes at Hampton for the past eleven years (1914–1924 inclusive) may also be worth noting:

Of the Valedictorians:	*Of the Salutatorians:*	*Of the whole number:*
3 were dark brown	3 were dark brown	6 or 28.5 per cent. + were dark brown
3 were brown	3 were brown	6 or 28.5 per cent. + were brown
3 were light brown	3 were light brown	6 or 28.5 per cent. + were light brown
1 was light	2 were light	3 or 14.2 per cent. + were light

[5] Omitting one Indian.

It is evident again that, so far as color may indicate the degree of white or Negro blood, it signifies little or nothing with respect to intellectual ability. Indeed, as one reflects upon the really *known* evidence, the actual facts, it seems high time to throw overboard the whole notion of the *general* superiority or inferiority of any race. Let it be freely granted that one race will excel in one respect—as the Finnish competitors in the Olympic games this last summer excelled in long distance running—and another race in some other respect. Every man may rightfully believe that his people are the chosen people to lead the world into one province of truth if not into another. The time-honored allotment of government to the Romans, philosophy to the Greeks, religion to the Hebrews, as their respective spheres of preeminence in world-history and their distinctive contributions to the progress of civilization represents an entirely reasonable principle. India has for ages believed passionately in the supremacy of the spiritual life; let us honor her for that and learn all we can from her, instead of looking upon her with coarse contempt because she does not compete with the West in mechanical invention and highly organized industry. The Chinese have always been admired by those who have really known them for their capacity for hard, painstaking work, their peaceableness, their honesty, their fundamental ethical soundness. Why despise them because they have not yet developed a Standard Oil Company or built a modern battleship or learned to regard a national championship in baseball as of more interest than a presidential campaign? So one may gratefully recognize the exemplary courtesy and loyalty of the Japanese, the mystical fervor of the Russians, the thoroughness and the tough-mindedness combined with tender-heartedness of the Germans, the clear if not always practical logicalness of the French, the artistic sensitiveness of the Italians, the sense of color and music and rhythm, the depths of patience and devotion, the indomitable hopefulness and cheerfulness which we find in the African race? Does not the world need them all? Can not we Anglo-Saxons learn from them all? Have not all these characteristic racial virtues a proper place in the vast pattern, the infinite fabric of the past, present and future life of humanity? Is it not worse than foolish, is it not ridiculous and abominable when we find members of the Anglo-Saxon race boastfully proclaiming *their own superiority* to the rest of mankind, chiefly because they happen for the moment to control politically and industrially a large part of the earth's surface? Does it not savor of what the old Greeks called ὕβρις, the shameless arrogance, the wanton insolence, which fears no law of God or man, and sooner or later receives the Divine punishment? We know what we think

of an individual who so thinks of himself more highly than he ought to think. Let us realize that a similar combination of resentment, ridicule and contempt is often excited in the minds of the members of other races by Anglo-Saxon self-complacence and condescension. Before we write books on our own race as "the great race," let us wait to be assured of that title by the scholars of some other race.

In other words, the existence of racial *differences*, points of strength and weakness, talents and lack of talents is and always will be plain and undeniable. Any sensible mother will admit that her children do not all excel in every good quality. One is superior in orderliness, another in literary appreciation, another in dramatic sense, another in the ability to learn foreign language, another in mathematics, another in financial acquisitiveness, another in philanthropy and so on. But will their mother claim all-round superiority for any one? Probably not.

In like manner, when we are comparing the races of the human family, let us confine ourselves to the narrow limits within which measurements and judgments can be surely made. Let us not talk broadly of physical or intellectual or moral excellence: let us divide and specify and differentiate. Only so can we reach justice and truth.

This is a small planet on which we dwell. It will never be any larger. We can not move off it. We must learn somehow to live together upon it in decent neighborliness. More than ever is it plain to-day that among men and women who call themselves civilized there must be no toleration of race-prejudice, but rather mutual respect and a growing good-will.

THE USE OF THE MEDIAN AS A MINIMUM REQUIREMENT FOR INTERNATIONAL MIGRATION

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THE improvement or impairment of the human stock of any country is dependent on the one hand on the relative quality of the immigrants and of the natives, and on the other hand of the infants and adults. Eugenic progress can be accomplished if immigrants are superior or if the children are superior or both. Should the immigrants as a whole and the babies as a whole be inferior, racial decline is in operation.

Eugenicists are, of course, very greatly interested in the differential fecundity of the components of a population, and at the same time greatly discouraged by the subfecundity of the more intelligent, to remedy which eugenicists are making a discouraging uphill struggle.

Let us turn then to see what might be done by the control of accessions by immigration. Here, on the contrary, we find a promising situation in that public opinion is already convinced that immigration should be greatly restricted and that it should be on some selective plan. The present immigration selection is defective because it is based on group characteristics rather than individual characteristics, and in each of these groups a very great range of variation with great overlapping is found. But by an extremely simple and wholly feasible plan we can adopt a procedure that accomplishes the eugenic desideratum—so that immigration can improve the race. This device is merely to exclude all below the median which is the theoretical individual inferior to whom are one half the population and superior to whom are one half the population. Thus no one is admitted who is not an asset. All liabilities are debarred. It is true that for any of the characteristics we might measure there are many individuals close to the median score and that the score would have some probable error so that the line may not be cut without a possible injustice to individuals above or below the median by a very small amount. Yet this is habitually done in civil service examinations and college entrance examinations. This slight injustice is relatively trivial as compared to the injustice of a very superior person found to have arrived just after the fulfilment of a quota, the previous successful person having been a dullard.

We pass now to the criterion of which the measure will be made. The desiderata of such a criterion are first ready and feasible quantification. Conforming to this criterion are physical, mental and educational tests. There is no difficulty in making tests of any one of these types with so wide a range, and so good a reliability that excellent quantification is attainable. I know of no other. Occupation and civil records are too variable and uncertain to permit feasible quantification. As at present, they will be of incidental use. Of the three tests mentioned, we may discard the physical test median because mental and moral values are of so much greater social significance and because physical condition is so variable during the lifetime of the individual. Educational tests offer greater usefulness and may well be employed if mental tests can not yet command sufficient public confidence, but the mere environmental factor is so much greater than in the best constructed

mental tests that the mental test is clearly the proper choice. A further advantage lies in the fact that one mental test has already been given to a large representative group of men and the results of a representative sample of it have been collated. While this was done separately for white and Negro draftees, the results are readily combinable in proportion in population. The resulting array shows, using the "combined" score, a median of *13.25* in a scale having a range of 0–25, the mode is *13–13.9* and the arithmetical mean is *13.30*. It is, therefore, seen that it is not a matter of great moment which kind of average is used, but for reasons already given the median is the best threshold. Some criticism may be raised that the scores in this array did not include some who were too inferior to arrive at military camps or on the other hand were exempted because they were already in officers training camps or exempted as indispensable to industry. Since these omissions come from opposite ends the effect is in some degree compensatory. An investigation of the facts would indicate roughly some slight correction of the median cited above, but it is certain to be very slight and while worth making, no great harm would result if the median, as here given, were to be used.

Of course, it is not proposed to use either of the two tests, Alpha or Beta of the combined scale, since psychometry has made great strides since those tests were given. Further the purpose of the new tests would lead to certain differences in their construction. After completion the new tests and the old would be given to several thousand immigrants to get the equivalent of the old median in the new tests. The language difficulty is not insurmountable. The tests would be prepared in about a score of the commoner languages and there would be a pantomime-administered test, using objects instead of paper and pencil for the illiterate.

The administration of the tests should be at about a dozen well-distributed permanent offices of the immigration bureau attached to various legations abroad.

While the new test would replace tests for feeble-mindedness and literacy, since the former is measured by the test and an illiterate above the median should be admitted. It is not proposed to abandon present requirements in reference to physical condition, social record, etc.

The plan is recommended for adoption by all countries. Obviously it is of most advantage to those countries who attract the largest number of applicants for admission. But it is also of international advantage, for it will most improve the stock of those countries whose resources make possible a great growth of population and hence it would be of greatest world benefit. Consider the

analogy of farmers who have the better land on which they can greatly increase the number of cattle. They are especially concerned with admitting only superior stock to their herds. Thus cattle as a whole will be much more improved than if he simply accepted without selection the offerings from other farmers who did not have the land to greatly increase their herds.

In conclusion I plead for a more rational test of immigration restriction, namely, one which would admit individuals superior to our median as obvious assets, and the exclusion of those inferior to our median as being those who would lower the quality of our stock. No temporary profit from needed labor can compensate us for the loss in permanent lowering of American quality by the admission of inferiors.

MODERN BUSINESS EDUCATION AND RESEARCH

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PRECISE definitions should probably come at the end of a discourse rather than at the beginning, but nevertheless it is sometimes necessary to mark out the ground in a preliminary way at the very outset, in order to avoid confusion. This is particularly necessary with the subject of business education and research, since this subject has seen a relatively recent development and has not yet undergone much standardization with respect to terminology.

In the first place a distinction in principle should be made between business training and business education. The former prepares for some particular commercial occupation, such as stenography or bookkeeping, and is not unlike vocational training for a particular trade. Business education, on the other hand, must be regarded as a grounding in the principles and laws that underlie business as a whole, with little reference to a specific commercial occupation, in which respect it is comparable to legal, medical or engineering education, as these have come to be conceived.

The distinction between training and education is important in all these fields, but in the field of business the distinction is not yet fully adhered to in practice. The development here has been so recent that commercial-training and business-educational courses are spoken of in the same breath, when only the one or the other is meant. Thus we have the anomaly of so-called "business colleges" which teach only stenography or bookkeeping and

"schools of commerce" in colleges, which offer cultural business courses pure and simple. Nor does the confusion end here, for a number of collegiate schools of business still offer a hopeless mixture of commercial training and business educational courses. Not only stenography and bookkeeping in secondary schools but many other special training courses of one kind or another are still passing for cultural educational courses in our schools and colleges. In this paper we will be concerned chiefly with business education and not with commercial training, although the two phases will of necessity have to be taken up together in the earlier paragraphs.

A similar need for clear-cut distinctions appears with respect to business research. Two distinct phases are to be observed—the one, research in or for or by business and, the other, research about business. Research in business, for business or by business is conducted for the purpose of immediate gain, such as the sales or marketing research carried on by some particular corporation, or business forecasting services prepared for and sold to business houses, or the broader studies of business problems pertaining to a whole industry which are conducted by an organization of the business men in that industry. Research about business, on the other hand, is not concerned with immediate gain. Its object is to gather basic facts about business as a whole for the purpose of deducing general principles. This type of business research is carried on mainly through our universities and through privately endowed bureaus or agencies, although some of the universities carry on research for business also. A little later we will go into further detail regarding these two forms of business research. Here I simply wish to point out that we will be concerned with both forms in this paper.

Turning to the development of business education and research and to their present extent, we note a phenomenal situation. On the educational side there has come a tremendous and increasing demand in recent years for courses in business, especially in the public high schools and in the colleges, but likewise in other institutions. The high schools of this country have shown unprecedented activity along all lines in the past thirty years, their enrollment showing an increase in that period of some 600 per cent., which is obviously out of all proportion to the increase in population. But with all this unusual total advance, enrollment in business courses in public high schools has increased three times as fast as the sum total, its increase in enrollment being 2,000 per cent. in the past thirty years. A recent survey has shown that at the present time anywhere from 25 per cent. to 70 per cent. of the high-school students in our large cities are enrolled in business courses.

A similar situation confronts us in collegiate business education. Thirty years ago the collegiate school of business was virtually unheard of in this country. To-day there are between 25 and 30 such schools with an enrollment of over 20,000 students. In addition, many colleges having no schools of business offer business courses in their departments of economics. On this basis a government survey for the college year 1921–1922 indicated a total of 103 collegiate institutions offering business courses to over 73,000 students and conferring during the year over 4,000 college degrees in business.

Nor is the picture complete with public high schools and colleges. Y. M. C. A.'s, part-time and continuation schools, corporation schools, trade-union colleges, correspondence schools and other private and governmental agencies have entered the field of so-called business education until all in all this represents one of the outstanding developments of the present generation.

Turning to the side of business research, the development in recent years has in its own way been quite as marked as has that of business education. It is more difficult to measure this in quantitative terms, for no adequate survey of the development in all its ramifications has yet been made, but from the information available, it is quite evident that the business research idea has spread to an astonishing degree in this country in recent years. The three most important centers of business research activity are the government, business itself and the universities.

The business research work of our federal government has become a staggering proposition. We take for granted so many things the government is carrying on to-day that we often lose sight of the fact that some of them are of exceedingly recent development and have expanded with unprecedented rapidity. This is particularly true of governmental business research carried on by the Departments of Commerce, Agriculture, Labor and other departments. It would take us too far afield to attempt any adequate survey of this development, so that one or two illustrations must suffice. We pass over the work of such well-known agencies as the Bureau of Labor Statistics or the Federal Census of Manufacturers. The work of the Bureau of Crop Estimates, operated by the U. S. Department of Agriculture, has been carried on for a number of years; but though widely utilized, the enormous amount of research entailed in this crop-reporting service is not generally recognized. The crop reports, issued monthly during the crop season, cover nearly one hundred different cereals, grasses, fruits, vegetables, live stock and other products raised on our farms and ranches. Data are secured through some 32,000 township reporters, 2,800 county

reporters, and a corps of paid state field agents and crop specialists. These data relate to acreages, conditions, yields, quantities and values, and are sent in on prepared forms to Washington, where a special crop-reporting board prepares the results for publication each month. These monthly estimates are remarkably accurate and furnish a most valuable source of reliable information for the business man.

Another illustration of what the government is doing along the lines of business research is seen in the recent creation, under Secretary Hoover's direction, of the Domestic Commerce Division of the Bureau of Foreign and Domestic Commerce. Its program of work, as indicated by the assistant chief of the division, divides itself into four phases: First, it conducts country-wide surveys and market analyses of commodities and industries; secondly, it prepares in convenient summary form data relating to production, consumption and general business conditions; thirdly, it disseminates this information through bulletins and public addresses; and, fourthly, it acts as an information bureau for the business man and makes special research studies on topics of current interest. This governmental division is building up files of important research data available to all. The way in which this bureau is serving American business men is indicated by the fact that 5,000 inquiries per day are now being received and that its work has doubled in the past two years. During the past year this bureau supplied information on 1,250,000 inquiries from American manufacturers, exporters, financiers and domestic merchants. Limited space prevents the inclusion of other illustrations of the striking way in which the government has expanded its business research activities in recent years.

In addition to the wide use being made of governmental facilities, business men are engaging in extensive researches of their own. Many large corporations have installed special research departments to deal with marketing and other immediate problems; but the most significant development here has come through associations of business men, the bankers, the manufacturers, the farmers, the railroad executives, the meat packers and other groups, who have pooled their interests and have opened up centers of business research activity of considerable proportions. A single instance may be cited where some thirty national associations of manufacturers have combined to form a conference board of manufacturers, which engages a staff of from eighty to one hundred people to carry on business research into problems of interest to all manufacturers. Something like 100 research reports have already been issued by this board bearing on such topics as wage changes, hours of work, cost of living, profit-

sharing, trade union agreements, works councils and other subjects in which manufacturers as a whole are interested. In addition, many of these thirty constituent national associations of manufacturers carry on research activities of more particular interest to their respective special fields. Supplementing this direct effort by business men themselves are such private enterprises as business forecasting, advertising or marketing bureaus, and the like, which sell the results of their researches in summary or graphic form to business men.

In the past few years the research idea has taken firm hold upon American industry. Business is endeavoring in innumerable ways to solve its problems by getting at the facts.

In this respect business is, also, coming to look more and more to the third center of research activity mentioned, *viz.*, the universities and other privately endowed institutions such as the Institute of Economics in Washington or the Bureau of Economic Research in New York. The most significant development in this direction has been the establishment of university bureaus of business research, some eighteen to twenty in the past four years. Some of these, such as the one conducted by New York University, engage in research solely *for* business and are financed through the payments for services rendered to their clients. Other university bureaus cover only that phase of business research we have designated as research *about* business. Still others, and notably the Harvard University Bureau of Business Research among them, carry along side by side both research for business and research about business. The Harvard Bureau has had such a remarkable development that a brief statement concerning it is in place here, both for the purpose of making the distinction between the two types of business research more clear and as typifying the astonishing growth along such lines in recent years.

Starting with a gift of $5,000 five years ago, the Harvard Bureau of Business Research now requires an outlay of something like $200,000 a year. The bureau is subdivided into three divisions, one of which carries on the administrative work. A second division is engaged in making research studies for certain wholesale and retail trades. The third division started three years ago on a small scale to make research studies about business for teaching purposes, through the preparation of selected business cases. The method proved so successful that during the past year this division had from twenty to thirty field agents engaged in the collection of business cases, in addition to the necessary supervisors and clerks in the central office to put the data into proper form as they were sent in.

A word should also be added regarding cooperation between the government, business and the universities in respect to business

research along certain lines. Within the past few weeks announcement was made through the press that research agencies and corporations in twenty fields were in process of combining their efforts, under the auspices of the Personnel Research Federation, "to weed misfits out of industry and to make its millions of workers happier, more efficient and more productive"—to quote from the announcement.

So much for the extent and the rapidity of growth of modern business education and research and the content of business research activities. We have still to examine more fully into the content of the business courses offered in our schools and colleges, in which connection the relation between business research and business education may be indicated. Regarding this relationship one can not do better probably than to quote from a recent report of President Burton, of the University of Michigan, in which he says:

> Research is a primary function of a true university. Only as scholars in every field are making contributions to our knowledge of the world, and only as mankind gradually but surely acquires a mastery of the universe, have we reason to hope for that progress upon which civilization rests. Moreover, it may be said with some show of truth that the teaching efficiency of a university is intimately related to its research activities.

President Burton's statement holds no less in the field of business education than it does in any other field of education. One can not hope for high-grade business courses unless these are based upon business research, and that is precisely what the Harvard method of collecting business cases is providing. Just as the case method of teaching legal principles put the law school upon a solid basis, so the case method of teaching business principles is raising the caliber of courses offered in the business school. Thus business research is aiding business education. In place of the descriptive matter in the ordinary text-book on business subjects, the book of business cases provides thought-provoking material for the student, prepares him for dealing with the kind of problems he will actually face in the business world, and, finally, through the care with which this case material is being assembled, gives him a thorough grounding in the broad fundamental principles of business. And at the same time that better instruction material is being provided by such agencies as the Harvard Bureau of Business Research, better equipped college teachers are being prepared in such institutions as the Harvard Graduate School of Business Administration, which, as we doubtless know, has recently been given a donation of $5,000,000 by a prominent New York business man for the purpose of expanding its work.

In spite of these advances, however, there is still much to be done in the matter of curriculum building. In the first place, as has been intimated at the outset, the content of collegiate business courses is not always up to college grade. In some instances, the courses offered are hardly more than high-school courses. In other instances, courses are offered in some particular form of business, such as the manufacture of textiles or the administration of trust estates, whereas the chief aim should be to provide training in those fundamentals which are common to all business. H. S. Person, in discussing the work at Dartmouth in 1920, pointed out certain standards in this respect. He said:

> During the more than fifteen years of our efforts at the Tuck School, we have been searching for the elements of a curriculum which are basic in the sense that they relate to elements in business which are universal in all business. We have come to believe that the differences between businesses which are ordinarily noted—that one manufactures or distributes shoes and another sugar; that one fashions or deals in tangible commodities and another offers services—are superficial from the educational point of view. Attention to these differences is essential, but too much should not be made of them. A curriculum, the elements of which are determined by a consideration of these superficial differences, is likely to develop limitations in the graduate rather than give him professional freedom and power. Have you ever considered the fact that it is an exceptional student who knows until the time of graduation what business he is going to enter, and that the businesses most students enter are determined largely by the opportunities presented at the last moment; also that five years after graduation the majority of graduates are no longer in the businesses they entered at graduation? These are significant facts. The inevitable conclusion is that the object of training for business should be the development in the individual of universal and transferable professional business ability. That alone will give him freedom and power and make him master of his career.

In the second place, so-called collegiate schools of business are themselves of differing grades. Certain schools, situated chiefly in large cities, offer a collection of business subjects, especially in the form of evening courses, to meet the immediate practical needs of the business world. Such schools render a definite service, but their aim is quite different from the aim of the collegiate schools which put their business courses upon the same plane with liberal arts or similar broad disciplinary work, and offer a course leading to a bachelor's degree.

Speaking of the standards a collegiate school of business should maintain, Dean Hotchkiss summed up the matter four years ago as follows:

(1) Business education must be considered, not as a thing in itself, but as part of the whole scheme of higher education;

(2) Schools of business are related to a college or university precisely as schools of law, medicine or engineering are;

(3) Such schools must have a professional aim, and furnish a basic mental discipline and a broad outlook regarding the principles of business.

Viewing the business school curriculum in relation to other work offered in a university, it is, of course, obvious that the course in business must be grounded in the work of the liberal arts department of economics. Furthermore, liberal arts requirements in the fundamentals of language, exact science and other social sciences besides economics must be maintained to provide broadness of outlook. In the department of economics, in addition to the general course in principles where the organization of industrial society is broadly indicated, courses should be offered, for the election of the student of business, in banking, transportation, trade, agriculture, mining and manufacturing; and the course in business principles, forming the basis of the student's technical training, should start with a résumé of these broad subdivisions of the economic structure.

The technical training of the business student may be thought of as beginning with an examination of the economic structure from the standpoint of the individual business concern. Various forms of business concerns, such as the proprietorship, partnership and corporation, are first analyzed, after which they are examined in the light of the broad functions the business man exercises, *viz.*, organization, coordination and administration. From another angle these functions may be regarded from the standpoint of ownership and control on the one hand, and business management on the other hand.

Business ownership and control involve the exercise of the organization function and the determination of the larger policies of a business. Here the broad problems of banking, transportation and of the other advanced economic courses should be summed up in their bearing on the formation of business policy. And this should be supplemented by courses in business statistics and the forecasting of business conditions.

Business management involves the exercise of the functions of coordination and administration and the carrying out of the broad policies laid down by the owners. This means a study of the main subdivisions of business management, such as finance, production, sales, personnel, accounting.

Such a course of study, covering both liberal arts and technical business subjects and providing a broad training rather than a detailed knowledge of some particular business, is the ideal to which collegiate business education is endeavoring to measure up.

But it can not fully measure up to this ideal (as has been said), until a sufficient supply of business case material has been pro-

vided, and until a sufficient number of properly trained teachers have been secured, not only for collegiate business education but for secondary business education also. Both these needs are now being filled.

We must hurry on from this somewhat cursory résumé of the extent and the content of modern business education and research to causal considerations. What circumstances have occasioned this rapid and unprecedented development? The answer is not far to seek. It is bound up with recent developments in industry.

The first fruits of the industrial revolution, *viz.*, factory production and the application of pure and applied science to manufacturing pursuits, created a need for technically trained men and for research as applied to technical production problems. This occasioned the rise of schools of engineering and technology. Beginning in 1824 in this country, isolated technical schools began to spring up, and after the Civil War this movement was stimulated by grants from the federal government. By 1915, 67 institutions of this nature, with 69,000 students, were in existence. Since the World War, there has been a still further increase. The technical production problems of industry are being solved in a most satisfactory manner.

But the industrial revolution also brought other results in its wake—alternating cycles of business prosperity and depression, banking crises and panics, transportation problems, wholesale paralyses of business through organized strikes and lockouts, more intense competition for markets—in short, an ever-increasing uncertainty, which came to plague the business man and which the solution of production problems only served to augment.

At first business men, the public, the government and even the economists were not aware that anything could be done to remedy these difficulties. But with their growing complexity, a realization finally broke upon all concerned that distribution problems, just like production problems, were subject to better understanding and at least partial if not complete solution. Thus research and education came to be applied anew with the results already indicated. Schools of business and bureaus of business research have come to the fore.

The modern business man is, on the one hand, demanding executives thoroughly grounded in an understanding of these broader business problems; and, on the other hand, he is insisting that facts regarding business conditions, marketing possibilities and the like be placed at his disposal.

The public has also become interested in these newer developments as they touch the public welfare, and has set about studying them through duly constituted governmental agencies. Unemploy-

ment, profiteering, tariff changes, speculation and like problems are followed with keen interest through the daily press, and this interest has been augmented by reparations and other post-war difficulties. This interest has drawn many young people to take up the study of economics in our high schools and colleges, while the lucrative rewards that come to successful business men in a country of free business enterprise has caught the imaginations of those preparing themselves for a life's career.

And last but not least is the better understanding of business problems on the part of economists themselves. Better and more readily understood texts are being written. Introductory courses are being given in our secondary schools. Economics has finally lost the stigma of the "dismal science" fastened upon it in the classical period and has become a fascinating field of study for many.

We come now to the last phase of the subject under discussion. What lies in the offing? What does the immediate future hold forth in respect to business education and research?

To the speaker this future looks promising in two directions. In the first place, it appears that the art of business and the science of economics are finally being placed upon an exact scientific basis. This should mean that our most insistent industrial problems will be brought much nearer to solution. It is facts and a scientific interpretation of facts which makes men free; and business men are clamoring as never before for facts. And the facts they are now seeking are basic for the science of economics. Facts about consumer's wants, facts about demand, facts about supply, facts about crops and prices and personnel and sales and advertising and markets and periods of boom and depression and about a hundred and one other problems that lie at the very heart of a proper understanding of economic principles. An economist can hardly be accused of ulterior motives when he says of his own field of study that it is not yet on a scientific basis. Such is precisely the speaker's position. Economics is still astonishingly shy of basic facts. Many theories still put forth have had no adequate testing out. But now that testing period has come. Business facts are being accumulated on all sides. There is no reason now why economics should not have as rigid a foundation as has biology or chemistry.

For this, however, something further is required beyond the mere gathering of facts. It requires comparison, interpretation, the formulation of general principles. Towards this end there are also hopeful signs. One is the growing suggestion that business research efforts be coordinated. Toward this end, the U. S. Department of Commerce is now carrying on a survey of existing business

research agencies and has constituted itself a clearing house for the exchange of business information. That such agencies are beginning to cooperate with one another was brought out quite clearly at the last annual meeting of the American Association of Collegiate Schools of Business held in May, 1924, in New York City. At the same meeting Chancellor Brown's suggestion that the time was ripe for the establishment of "great libraries of commerce and industry in which all manner of business research can be successfully prosecuted" was met with a hearty response from the delegates.

The second direction in which the future looks promising lies in the creation of better professional standards for business. Last May the U. S. Chamber of Commerce, representing some 1,300 local trade bodies, with an underlying membership of several hundred thousand business men, adopted a code of ethics for business, which is now before the various local bodies for their ratification. This action has led certain enthusiasts to take the position that forthwith business is being raised to the same professional plane that medicine, law and engineering are on. But what is apparently being overlooked in drawing such a conclusion is that the mere adoption of a code of ethics (as laudable a step as that is) has not placed the professions on the plane they occupy to-day. Medicine had its code of ethics laid down for it by the great Hippocrates over 2,300 years ago, but this did not prevent scandalous and widespread malpractices. Finally, society was forced to take the matter in hand and set the standard for admission to practice; and it is these standards, revised from time to time, which constitute the professional standards for medical practice to-day. Society has also set professional standards for the practice of law and is in the process of setting them for the practice of engineering. Broadly speaking, these professional requirements consist of a college degree in medicine, engineering or law, the serving of an interneship or clerkship or something similar, and the passing of examinations or other community tests.

The business man is exempt from any such requirements. The effect of such standards, socially set and rigidly enforced, is to automatically exclude the worst of the charlatans and the unfit and to secure the confidence of the public in those who are admitted to practice. As a result, society can expect more from the professions than it can from business as it still is. In spite of the ever-recurring crop of shyster lawyers and quack doctors and a certain deplorable professional secrecy, we have come to expect fine things from doctors and lawyers and are shocked when they fail to measure up to expectations. Business, however, is not as yet regarded from the same angle. We say "business is business" and we imply nothing complimentary by that phrase.

A code of ethics for business, comparable to the codes already in use by the medical, legal and engineering professions, has been advocated in many quarters for a number of years. The public has just about got enough of the predatory slogan of "business is business," and the pressure of public opinion has undoubtedly helped to secure the recent action of the Chamber of Commerce, though there are many high-minded men in the business world who are just as impatient with predatory business methods as the public is. Society is asking itself why it should expect less from the business man than it requires of the doctor or the lawyer or the engineer. It is wondering if professional men affect the lives and destinies of their clients any more than the business man affects the lives and destinies of his employees, not to mention the consumers. The adoption of a code of ethics, as important a move as that is, is not enough. If business is to be placed upon a professional basis, standards must also be adopted and enforced.

It is conceivable that business will raise itself to a professional plane without the intervention of society, but whether professional business standards are set voluntarily or forced from without, the requirements must undoubtedly be the same as they already are in medicine, law or engineering, *viz.*, a certain educational background (usually covered by the securing of a college degree) or the passing of certain technical tests or both.

Business research will undoubtedly aid in raising business standards, for as the facts about business become more fully and generally known, it will become more difficult to engage in questionable practices. But by far the greater influence in this direction is collegiate business education.

In this connection Professor Lyon, in his book on "Education for Business," makes the following carefully guarded observation:

> The collegiate school of business has justified itself if it has improved production and organization, and perhaps it can not do more. The field of the collegiate school of business may be limited to improvement in technique and in organization. If this is the limit, however, it is unfortunate. It will be regrettable if the collegiate school of business can not develop a corps of business men capable of guiding society. It will be regrettable if the collegiate school of business can not place clearly before its students the underlying assumptions of a business world; if it can not bring its students to see that captains of industry are as much needed properly to place business and to limit it, as they are to employ it and exercise it. Only with some such objective can the study of business in any sense apply to itself the notion of a profession [pp. 390–1].

We may add to Professor Lyon's observation that there is no reason why a liberal arts background and a thorough training in principles can not do for business what it has done already for

medicine, law and engineering. In the United States more than 4,000 college degrees are now being conferred annually in the field of business education. Many of the recipients of these degrees will be leaders in the business world in the years to come. Thus side by side with the sordid double-dealing of the market place and the spirit of the devil take the hindmost, we are already finding the collegiate spirit of *noblesse oblige* and the vision of the future based upon a contact with our highest social and intellectual heritage as it is secured through a liberal arts education. In this respect, collegiate business education has a high mission to fulfill.

EMPLOYE REPRESENTATION

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NOTHING is more obvious to the reflective mind to-day than that the whole concept of conflict needs thorough revision. The struggle concept is an old one. Biology has long since familiarized us with the idea of the "survival of the fit" through conflict. Youth and old age are forever in conflict. In our industrial life a deep-seated, persistent feeling is very generally voiced, that there prevails inevitable conflict—conflict between employer and employe; between producer, middleman and consumer; between banker and manufacturer; between merchant and merchant; between worker and worker. The state is the arena in which social welfare arises from the battles of conflicting interests. The entire technique of justice, as carried out in our courts, is a regularized conflict technique, designed to bring about a judgment that will "close" the controversy. The church is divided through conflict—fundamentalist arrayed against modernist. The whole world is in a state of conflict; religion set against religion, race against race, nation against nation.

Now no phase of this universal conflict-state is more vital to us all than the economic conflict, more particularly that aspect of it observed at the centers of the productive processes—the conflict between employers and employes. Society is dominated by a machine technique. The deepest feelings, both noble and ignoble, surge around and through the economic forces. "The economic relations are all comprehensive enough to include both heaven and hell." Here we need new incentives, new solvent concepts, great industrial statesmen to lead us into the light and harmony of a new industrial day.

At this point let me interject a few quotations:

The great tides of the world do not give notice that they are going to rise and run; they run in their majesty and overwhelming might, and those who stand in their way are overwhelmed. The forces of the world do not threaten, they operate.[1]

Science and religion, the elder brothers of social life, must draw closer together in cooperative social action; science absorbing the more hopeful and spiritual qualities of religion, and religion the more progressive and frankly intellectual qualities of science. Every phase of man's education must emphasize the creative law of cooperative egoism and altruism, or the universal obligation to self-aggrandizement for the purpose of self-giving. This elemental creative law is the fundamental lesson of social life. Unless it is well learned, forming a basic part of man's personal character and of his social institutions, his intelligence will be devoid of its most essential human quality, his learning vain, and his social life a failure.[2]

Somehow, if progress is to be made, new codes of action must be drawn, under which the difficult adjustment of individualism to group responsibility shall be shown to be practicable and in which the two motives shall be blended. No greater challenge can be issued to the college in its capacity as representing the world of education.[3]

The most natural bond between individuals is that of cooperation in a common enterprise.

An association, to be vigorous and effective, must faithfully reflect the will of its adherents and form an intimate part of each adherent's interests. Mankind, as a whole, is instinctively communally-minded. Industrial management is thereby presented with the opportunity of making the factory rather than the class the basis of association.[4]

The gradual development of the equality of conditions is a providential fact, and it possesses all the characteristics of a Divine decree: It is universal, it is durable, it constantly eludes all human interference, and all events as well as all men contribute to its progress.

The first duty which is at this time imposed upon those who direct our affairs is to educate the democracy; to warm its faith, if that be possible; to purify its morals; to direct its energies; to substitute a knowledge of business for its inexperience, and an acquaintance with its true interests for its blind propensities; to adapt its government to time and place, and to modify it in compliance with the occurrences and the actors of the age.

A new science is indispensable to a new world.[5]

As a result of gradual evolutionary processes, advanced industrial countries are coming under the influence of a law as pervasive, comprehensive and dynamic as any of the laws of physics, chemistry or metaphysics. This law has been discerned by a few far-sighted

[1] Woodrow Wilson.

[2] W. Patten, "The Grand Strategy of Evolution."

[3] President Ernest M. Hopkins, annual address to students of Dartmouth College, 1924.

[4] Oliver Sheldon, "Philosophy of Management."

[5] A. DeTocqueville, "Democracy in America."

statesmen. President Wilson had it in mind when he declared that "great movements do not threaten, they operate." But this law has not been comprehended by the vast majority of men whose lives it is reshaping and whose future it is definitely to revamp more than any other force now operating in society.

I believe this law to be a law of nature, based on her constructive, cooperative processes of evolution, her biological law of egoism and altruism, of give and take. This law I would state as follows: *Power with increasing momentum is passing from the few to the many.* This law emphasizes the great necessity for group loyalty and group solidarity.

The full import of this principle is only understood by comprehending the scientific data gleaned from biology, physiology, psychology, economics, politics and ethics, revealing the organic life processes of the physical, intellectual and spiritual unity of mankind. The world, and particularly industry, is in chaos to-day largely because man's organic nature is not thoroughly understood. What some recent psychologists call "the total situation" in which man moves has not been duly conceived, observed, analyzed, evaluated. Man's work relations and his life ties have been regarded too much as incompatible, rather than as interpenetrating influences. The intimate interrelation between man's habits of thinking and his habits of doing has not been adequately understood. We have not taken a conscious, deliberate, responsible organized attitude toward our total daily experiences. President Hadley recently called attention to this lack in developing all-around personality, due to the overemphasis placed on the distinction between learned and unlearned occupations. He stressed the necessity of professional training in the telling qualities of observation, accuracy and self-reliance: for knowledge is power only as it is combined with self-reliance in thought and action.

In the October, 1924, issue of the *Yale Review*, Mr. L. P. Jacks very wisely emphasizes the absolute necessity of so understanding, organizing and directing future industry that the masses of mankind may literally get culture therefrom. To Jacks "education is the process of training the industry of man, in its manifold varieties and in its organized totality, to the highest pitch of excellence it is capable of attaining. The only type of education appropriate to an industrial civilization . . . will have its roots in the actual labor of mankind and will return into that labor to endow it with higher qualities and more valuable aims."

Many significant consequences flow from the redistribution of power now taking place in our economic and social life. Among these the most far-reaching, for our purposes, are the following:

(1) The pressing need for the spread of organized, consciously directed education. One of the wholesome effects of the employe representation movement is the spread of economic intelligence. These joint arrangements force the essential facts bearing upon a given situation into the consciousness of those whose lives are most directly affected by them. The daily work experiences thus become a dynamic reality.

(2) This law of the growing equality of conditions, if it is to be directed into wholesome channels, demands a growing appreciation of the importance of the diffusion of property. Professor Carver, of Harvard University, has recently stressed what he calls the evolution of the "labor-capitalist class." Professor Carver believes that we are evolving into an equality of prosperity more rapidly than is generally realized, and that "unless we embark on some unsound policy, the present tendency will carry us further than most of us dream. The processes are now at work under capitalism, under freedom, under voluntary agreement among free citizens, which will put such great power in the hands of our manual and clerical workers that it will enable every occupation to prosper." It is significantly in harmony with the growth of democratic power to know that where employe representation plans have been wisely developed there is a growing appreciation among the rank and file of the significance of this evolution of the "labor-capitalist class." There is a more intelligent interest in saving, a better understanding of the problems of investment, of the significance of stock-ownership and profit-sharing plans.

(3) The redistribution of power flowing from the law stated above is a positive economic and social danger unless we develop with it *capacity* for and *practice* the *habits* of constructive cooperation. In his essay on "Civilization," John Stuart Mill declares that "growth in the capacity for and practice in the habit of cooperation is the surest test of an advancing 'civilization.'" We need a great deal of probing to get at the true principles of group organization, understand the processes of joint control and evolve sound comanagement maxims. If cooperation is to be of lasting benefit, it must become the means of working out an integration of motives and interests, of ideals and standards of justice in industry.

The noted English economist, John A. Hobson, in addressing one of my classes recently, declared that the greatest need of the world to-day is a keener sensitiveness with reference to the sense of justice. Sensitiveness is of the very essence of democracy. The employe representation movement is helping employers and workers realize this fact.

The spread of economic intelligence, the diffusion of property and growth in the habits of constructive cooperation are the strik-

ing characteristics of the democratic law of our times. We are here concerned only with the third of these tendencies—a modest attempt to set forth some of the more significant phases of cooperation as expressed by the employer-employe representation movement. Many influences during and since the war have helped accelerate cooperative arrangements between management and workers. Among these may be mentioned, in passing, the forced determination of shop policy during the war and the influence of governmental operation of industry; open channels of communication as a preventive of costly labor turnover and as a precaution against strikes; joint action as a solvent of ill will and destructive friction; the shortage of labor supply due to restrictive immigration; and a growing conviction that trade unions are here to stay. Among the transforming subtler influences may be mentioned the growth of scientific knowledge. The humanistic sciences are slowly but surely shaping the work relations, humanizing them. Psychology is helping us work out standard methods of measuring and controlling human behavior. It is giving us a more rounded view of life and its organic meaning. We are studying adult behavior in the work relations under controlled conditions. A new business philosophy is emerging—a philosophy demanding that utilities shall be prosocial and brought forth under wholesome human relations. The employe representation movement is among the most significant experiments in our whole economic and social life. It has already, where in operation, revealed a most wholesome influence on the manners of management—on the customs, traditions, habits, opinions and feelings. It has done much to disintegrate prejudice. It is revealing the creative possibilities in conflict.

The employe representation movement is gradually emerging from its experimental stage. It is now entering the stage of constructive accomplishments. Many of the earlier plans, brought forth by the compulsion of the war period, have been modified or have passed away. Many others, born possibly of ulterior motives, have likewise ceased to be. In the main, the plans surviving the rapid post-war development, and the subsequent period of industrial depression, together with those of most recent adoption, are based in major portion upon a more constructive analysis and procedure, upon a clearer conception of the meaning of conflict, upon wholesome objectives. Employers, workers and society are becoming more conscious of the inner meaning of the movement. Both employers and workers now often conscientiously and loyally subscribe to the cooperative principles, technique and goal they have jointly determined. It is helping us understand the aim and significance of a unified democratic life.

Concretely the objects of these cooperative arrangements may be stated as follows:

(1) To provide organization and procedure for collective negotiation regarding hours, wages, working conditions and other terms of the employment contract, particularly affecting the welfare of the workers.

(2) To facilitate organization and procedure for the prompt adjustment of individual and group complaints and grievances—giving special heed to the word "prompt."

(3) To facilitate preparation of subordinates for positions of responsibility by familiarizing them with the needs and demands of the larger managerial problems.

(4) To provide a "double track" channel of communication through which management may learn more about employes' desires and needs and may inform them of its plans and purposes in so far as they are likely to affect the mutual interests of workers and management.

(5) To aid employes to appreciate the difficulties of the managerial function, not only regarding matters of hours, wages, etc., but also policies affecting finance, production, sales and the administration of public relations.

(6) To afford employers, workers and the public an opportunity to find out what they think about their thinking on one of life's most fundamental problems—the human relations in industry.

The earlier doubts, the distrust of the employer's ulterior and secretive motives in creating works councils and fear of workers' radical tendencies are giving way to a wholesome, constructive, mutual confidence and respect. The movement is allying itself with the scientific method, which disintegrates jealousies, suspicions, misgivings, subjective opinions. This tendency to bring the industrial partners to grips at the center of the productive processes is most promising. It is bound to broaden the works councils from the earlier, narrow consideration of problems of hours, wages, working conditions and grievance adjustments to the constructive participation of the workers in the formulation of administrative policies and the solution of managerial problems. The movement is being understood more and more as a growth. Hence methods, technique, means, not ends, are being emphasized. Less time and energy are being given to questions of constitutional form. A smooth, effective mutually satisfying operation is being stressed.

A list of industrial corporations, estimated at above seven hundred, at present operating under some form of employer-employe cooperation would be imposing in length and probably would number 1,225,000 workers, including many of America's leading indus-

trial companies, railroads, etc. Likewise, an inventory of the subjects — jointly analyzed, evaluated and settled by responsible executives with committees of their employes, shows with what sincerity and seriousness management and workers regard their joint arrangements.

Despite the wholesome evidence that progressive managements are convinced that works councils are a constructive aid to sound industrial relations, many questions of policy, principles and technique await clarification before mutually satisfactory results are firmly established. Many problems of a general nature await solution which only time and wide experience can solve. What are the most significant tests for measuring the success of a plan of employe representation? Should the basis of employe representation be the entire system of a company or its separate branches, such, for example, in the case of the railroads, as the train service, maintenance of equipment service, shops, offices, etc.? Is there need to supplement employe representation by some form of extra financial incentive, *e.g.*, stock-ownership, profit-sharing, "economy dividends," etc.? Can trade unions, with their present full-time officials, be incorporated in the employe representation plans, and would such inclusions be desirable? If employe representation becomes well established, what functions remain for the Railroad Labor Board? The solution of many problems will depend upon local situations, such as the composition of the working force as regards sex, nationality, occupation, unionization, etc.

The movement has too often been jeopardized by the common habit of unthinking imitation. It is dangerous in these times for management to move without a clearly defined, freely assented to dynamic creed. A convincing creed should represent clear convictions, sound ideals, workable principles, a tested technique. This, however, does not mean *fixing a goal*. The only safe goal is honest *experimentation* and growth. Definite commitments in this democratic procedure are dangerous. Grave mistakes have been made in this particular. Further, to regard the employe representation movement as essentially a substitute for unionism not only arouses futile destructive opposition, but destroys the opportunity to make of it a constructive instrument furthering the ends of a prosocial production and wholesome, happy human relations.

Unionism itself is doubtless destined to undergo important transformation. An ultimate integration between a new type of unionism and employe representation, though not yet clearly discernible, is, in the judgment of unbiased thinkers, not impossible. In some industries already, for example, some of the railways, and others, certain forms of shop representation and unionism are working side

by side. In these cases there seems to be no mutual hostility. Rather the two aspects of the resulting industrial government have proven reciprocally helpful. Best of all, the contact of the two movements has fostered interest in the problems of production and has promoted industrial efficiency. Certain of the unions of railway workers have joined with the management of the Pennsylvania system to make effective employe representation on that railroad. In many plants, throughout the country, union members have been elected to works councils. At this point many important questions suggest themselves. The attitude of national union officials, whose contact with the employe representation movement has been remote, is often one of direct opposition. What is the attitude of the local union officials who *live* with the movement? What is the attitude of the average union man on the firing line of employe representation toward it? Is he furthering its constructive possibilities or is he opposing it? Has the shop committee movement modified policies or the objectives of unions? Particularly, has it aided them in appreciating the scientific method in shop-practice? Has it in particular instances tended to weaken the hold of unions upon their members? What has been the attitude of union members when elected to works councils? What has been the serviceability of employe representation in bringing to the front the best type of leaders among employes?

These and many other questions of similar nature must be answered on the basis of accurate observation, analysis and evaluation of local facts.

Many sincere employers believe that the employe representation movement affords a more helpful medium than trade unions for joint negotiation to determine hours, wages, working conditions and the settlement of differences arising under the terms of employment. The constant, frequent, friendly contacts between management and workers; the continuous full access to all the facts in a given situation; more intimate acquaintance with the management's desires, actions, habits of thoughts, etc., are advantages which may offset the lesser business experience, freedom of action and broad industrial viewpoint of council members as compared with union business agents. These and other advantages inherent in the employe representation movement may invalidate the claim of some professional union labor leaders that workers unaffiliated with employes in plants of other employers are powerless to gain substantial or permanent advantages from employers. It is a serious matter for an employer to commit his company to the employe representation movement. The purpose of such plans is in order to obtain definite, accurate knowledge of workers' honest desires, just needs,

fair settlement of disputes, etc. Such knowledge the employer counts an asset. Having embarked on this course, the employer must reasonably satisfy workers' demands or furnish adequate reasons for not doing so. To abandon plans entered upon is to destroy confidence in managerial integrity and wisdom and to make more difficult future practice in dealing with workers.

A critical evaluation of the employe representation movement is bringing to light the fundamentals of the human relations in industry. It is significant that there is a conscious, growing conviction that the proper and true relationships between management and workers is not one of continual strife. In the words of General Atterbury, of the Pennsylvania System: "The underlying foundation is that the mutual relationship is one of harmony and accord and is conceived and carried out on the threefold basis of mutual faith, facts jointly established and fair play."

DeTocqueville, the master mind of democracy, long since declared that "whatever exertions may be made, no true power can be founded among men which does not depend upon the free union of their inclinations." What does this mean for business managers and their employes? Are we not justified in deducing from it the logical conclusion that if we are to have true efficiency and harmony in the work relations, managers and workers, or their representatives, must exercise not superior force, but a right; that authority must rest upon proven worth and wisdom; that obedience will be increasingly rendered, not to a man, but to improved industrial law and to justice?

Are we not coming to recognize that the idea of voluntary agreement among those most interested in decisions at the pivotal point where issues arise is of the essence of cooperation in industry? Is this not the way to open up channels for the free flow of facts, knowledge, hopes, aspirations, wisdom (which cometh from discussion)? Would such a "free union of their inclinations" not tend to awaken and foster at the centers where energy should be developed a keener sense of personal responsibility in workers? Industry needs a more conscious, deliberate, responsible, organized attitude on the part of all its participants toward their daily work experiences.

As stated at the outset, the whole concept of conflict needs thorough revision. Too much conflict is destructive. We must come to think of conflict as a challenge, as life-giving, as an opportunity for creative thinking. If the conflict situation is entered upon with a sincere purpose to use it as an occasion for organizing and integrating thought, will, purpose, rather than as an opportunity for winning a decisive victory over one's opponent, then it may become

a most fruitful stimulus to creative thinking, bringing about a settlement which will result in life's most fundamental satisfactions: scientific discoveries, increased productivity, harmony in the human relations and moral values.

THE ECONOMIC IMPORTANCE OF THE CONSERVATION OF VISION

By MICHAEL V. BALL, M.D.
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To the casual observer as he notes the great army of children wearing glasses, as he reads the reports of various welfare societies that 30 per cent. of our school children have defective eyesight, that 50 per cent. of the men engaged in industry have poor vision, it would appear as if the vision of the people of the present age was rapidly deteriorating, as if there was a great need for some concerted and extensive effort to conserve what vision we have lest we become a country of the blind where the person with good eyesight is considered a freak and undesirable.

It is my intention to bring before you a few facts and figures in order to show you that there never was a golden age of vision, and that if glasses were much less in vogue 100 years ago than they are to-day, it was not because they needed them a bit less but rather because they were not so aware of their needs.

Statistics on blindness have been gathered extensively and by very careful observers in many lands, and they show that *everywhere total blindness is on the decrease.* Thus in the United States in 1880 there was one blind person to every 1,032 inhabitants or 49,000 blind in all, in 1890 there was one to every 1,238 persons, in 1910 one to every 1,600 and in 1920 one to every 2,000 or 52,560 in all. Nor is it difficult to understand this when we analyze the causes that induce blindness.

Previous to 1880 a survey of the inmates of the Blind Hospitals and Homes of Europe and America disclosed the fact that 25 per cent. to 30 per cent. of the blindness came from a single disease, a disease contracted at birth within the birth canal and of such virulence that it speedily destroyed the delicate cornea, leaving the eye irrecoverably sightless. With the advent of bacteriology and the discovery that a simple remedy, even mere cleansing of the eyes at birth, if used, would prevent this inflammation of the eyes of the newborn, an almost immediate reduction in blindness from this cause was obtained all over the civilized world, and to-day less than

4 per cent. of the blind owe their affliction to this cause. In fact, in the largest maternity hospitals in the world the disease is a rarity and all because nurses and doctors are taught to consider every newborn babe as possibly infected and to use cleansing solutions and antiseptics as a means of prevention.

Again, it was estimated that 35 per cent. of the blind in the days before Jenner, *i.e.*, in seventeenth and eighteenth centuries, were made so by smallpox. Smallpox was as prevalent in those days as measles in our time and thousands lost the sight of one or both eyes when the pustules affected the eyeball. In the 11th U. S. census 1.4 per cent. of the blind attribute their blindness to this disease and even in 1920, among some 26,000 cases of blindness from all causes, smallpox is responsible for 230 cases. In eastern countries, where smallpox is still virulent, blindness from this disease is not infrequent. In Mexico, Ruiz in 1922 reports 20 per cent. of blindness due to smallpox. A third great cause for blindness of former years, and the blindness in several tropical countries to this day, is a contagious disease of the lids known as trachoma and as Egyptian ophthalmia and granular ophthalmia.

During the great famine in Ireland nearly 87,000 persons were treated in the workhouses, suffering from this malady, and it has afflicted large armies and navies wherever crowding occurred. Even in the World War, due largely to the influx of Chinese soldiers, over 5,000 British soldiers were rendered temporarily blind by this disease. Its contagiousness was not known until the nineteenth century. Discovered among the school children of New York City a few years ago it was energetically combatted by the treatment of all affected children and successfully kept from causing serious damage. In some of the southern rural districts this disease has been treated by the United States Public Health Service.

The immigration authorities refuse admission to any one showing even mild degrees of the disorder and in this way trachoma has been almost stamped out of the United States. At least it is no longer a factor in causing blindness among our people.

Thus three great causes of blindness prevalent one hundred years ago have been fairly well placed under control and need not play any conspicuous part in the statistics in the next fifty years.

About the year 1866 a German oculist, H. Cohn, of Breslau, made some studies among school children and showed that nearsightedness (myopia), was common in the higher classes and of increasing frequency from lower to higher grades. This was the beginning of medical inspection of school children. Dr. Cohn advocated many changes in the lighting of schoolrooms, size of desks, size of type and kind of paper in order to prevent nearsightedness,

which seemed to affect 50 per cent. of the children in the high schools.

Myopia in its aggravated form, besides greatly affecting vision in the distance, leads to serious changes in the eye ground and is responsible for some forms of irremediable blindness. Some cases of myopia grow rapidly worse and beyond correction with any strength of lens.

The campaign, therefore, to lessen nearsightedness among school children helped to diminish another cause of blindness and by correcting early in life the slighter errors undoubtedly has done much to prevent the very severe forms of nearsightedness.

Myopia still forms about 16 per cent. of all the defects for which persons wear glasses. But while myopia has not been lessened as much by these efforts as was expected or predicted, a great handicap has been removed from millions of children who without medical inspection would have been obliged to struggle through school life with greatly diminished vision.

Nearsightedness is not all due to close application of the eyes as in school work. It is often found in the illiterate and is often noted in several members of the same family. Some investigators believe it is found more often in some shapes of skull than in others, that there is an anatomical basis for myopia and these anatomical peculiarities are transmitted through several generations, that the sclera of the eye is less resistant in some individuals than in others and permits a stretching or elongation of the eyeball. Therefore, we must not expect to stamp out nearsightedness as trachoma and smallpox have been combatted.

There is another group of eye diseases estimated as causing about five per cent. of all blindness that is clearly inheritable and that with more satisfactory marriage laws might be lessened. Families in which certain forms of blindness are inclined to appear should be made to realize the possibility of such transmission and either avoid bringing children into the world or be bonded to insure the cost of rearing the blind if born. In 1910 it was estimated that hereditary blindness costs the people of the United States two million dollars annually.

The last great factor in the destruction of vision is to be found in industrial accidents. Here, too, we are happy to say that great progress is being made. Industrial accidents, it is estimated, are responsible for 13½ per cent. of the blind. In the state of Pennsylvania in 1923, 600 eyes were reported as permanently blinded through an accident while at work and nearly one million dollars was awarded for this cause. In the metal trades 50 per cent. of all accidents pertain to injury of the eyes.

Through the efforts of the insurance companies and welfare organizations and large employers of labor, preventative measures have been instituted with an almost immediate result in lessening the eye accidents.

Thus in one large factory where over six per cent. of all employes were subject to eye injuries, after six months' determined application of the use of goggles and the immediate treatment of injured men, eye injuries affected only 1.6 per cent. of the employees—about one fourth of the number. Other large companies report a reduction of 75 per cent. in eye accidents where the men are made to wear a protecting goggle.

That faulty vision itself may lead to accident is the belief of some who would urge proper examination of all persons engaged in industry and correction of their defects as a condition of employment. Railroad employees have been subject to this requirement for many years, as it is recognized that a person with faulty vision could not be entrusted safely with a locomotive.

A steel worker who has one blind eye would be in serious danger if the sound eye were injured with a scrap of metal while he was working on some high scaffold.

The better adaptation of men to their work would come from the information gained by an annual inspection of the eyes of workingmen.

That eye strain is responsible for symptoms referable to other organs is a fact attested to by the records of any reliable oculist. That the correction of such eye strain on a large scale in industrial establishments would tend to greater efficiency as well as lessening eye accidents is the claim made by a number of writers on eye conservation. The question of providing proper illumination in order to prevent eye strain has been considered by engineering societies, and here, too, the results obtained in improving illumination have been worth far more than the cost.

Thus while we are told on the one hand that 30 per cent. of our school children and 50 per cent. of the workmen, or approximately 25 million of those gainfully employed, have subnormal vision, we are reasonably sure that there is less blindness in the world to-day than there ever was, that there is less serious eye disease than there ever was, that the visual acuity of our generation is as great if not greater than it ever was and this in spite of the excessive demands made upon our eyes by our twentieth century occupations and amusements.

The fact that our children resort to corrective glasses in greater numbers than did the children of a century ago is no more an indication of poorer vision in the former than is the fact that because

there are 16 million autos in use in the United States an indication that our legs are growing weaker and we are less capable of walking.

We want to continue to conserve vision by every possible method, and we in the profession of ophthalmology are proud of the results so far obtained.

Now the economic importance of the conservation of vision is almost self-evident. A blind person is practically helpless.

The cost to the nation of the blind exceeds 11 million dollars annually or an average of $300 per year per patient. The individual that loses an eye in an industrial accident costs over $1,000 directly, which is a tax on all the people, and indirectly reduces the earning capacity of the individual for the balance of his industrial life. Many occupations are closed to the man with only one eye. Reduction in vision less than complete that may result from disease or injury necessarily interferes with efficiency.

Eye injuries alone, which according to competent authorities form about one tenth of all industrial accidents, cost the country 23 million dollars yearly in the form of compensation to employes for time lost and there is a loss of like amount to the employe, as he never receives full wages for time lost. If by a minimum outlay it is possible to prevent 50 per cent. of the eye injuries in industry, the immediate saving in money and time is considerable.

If the permanently blind are lessened in number by any general measures such as interdiction of marriage of those afflicted with hereditary blindness, cleanliness and antiseptics during childbirth, prevention of contagious diseases during infancy, detection of early errors during school life and inspection of those employed in hazardous trades, the saving can not be measured in dollars alone. Fortunately, such measures are in operation and are proving their worth.

ECONOMIC ASPECTS OF HEART DISEASE

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NEW YORK, N. Y.

To attract your attention to the subject of heart disease, which may seem exclusively medical, it is perhaps unnecessary to do more than state[1] that in this country for the past few years it has been,

[1] "Early recognition and economic aspects of heart disease." Read before the Section of Social and Economic Sciences, American Association for the Advancement of Science, Boston, Dec. 28, 1922. Published in *J. A. M. A.* April 7, 1923, Vol. 80, pp. 971–973.

and still is, the greatest single cause of death. It accounts for over ten per cent. of the deaths from all causes. If one considers the monetary value of the losses in labor and life they mount into the billions, and such losses are the more amazing when one realizes that in great measure they are preventable. These losses are a wasteful toll upon the production, distribution and consumption of wealth and thus have very definite social aspects. Not only are these economic and medical phases of heart disease evident, but because they involve appreciable fractions of the population and elements of ignorance, vice, crime and poverty, which the individual unaided can not successfully combat, they may be also considered of importance to the public health.

The yearly loss by death from heart disease is greater than that from tuberculosis or cancer, which for many years have been, and still are, recognized by public opinion as well worth attention.

Though there may be controversy as to whether there is an increasing death-rate from heart disease, there is little doubt that the mortality among white females and in the colored of both sexes is very definitely increasing.

It has been asserted by a careful writer[2] that a child at ten years of age is, under present-day conditions, three times as likely to die eventually from heart disease as from tuberculosis. The disparity between the chances of death from heart disease and from tuberculosis increases with advancing age—more rapidly for females than for males. At age of thirty the male is nearly four times as likely to die from heart disease as from tuberculosis; the females are six times more likely to die from heart disease as from tuberculosis. It is shown, also, that at age of ten one in every five of the living will succumb to organic heart disease.

In 1922[3] it was estimated that the loss in continental United States and Canada would be 180,000, of which 57,000 would be among the insured. This loss is not restricted to old people, for about five per cent. are among children under fifteen years and fully 30 per cent. involve persons under fifty years of age. The average age among insured persons at death from heart disease is only fifty-six years, while at fifty-six years the expectancy is seventeen years more.

The importance of the mortality from organic heart disease has been stated in terms of comparison with the infectious diseases of childhood; thus between one and four years of age heart disease causes one third as many deaths as scarlet fever and one quarter

[2] Statistical Bulletin, Metropolitan Life Insurance Company, November, 1924.

[3] Dr. A. S. Knight, "Life waste in 1922," address at the sixteenth annual meeting of the Association of Life Insurance Presidents, December 7, 1922.

as many deaths as whooping cough. Between five and nine years of age heart disease causes more deaths than do any of the so-called children's diseases, excepting diphtheria, and has a higher death-rate than tuberculosis. Between ten and fourteen years of age heart disease has a heavier mortality than all four children's diseases combined.

From the same source it is learned that between twenty-five and thirty-four years of age organic heart disease causes as many deaths as lobar pneumonia. Between thirty-five and forty-four years of age organic heart disease causes more deaths than chronic interstitial nephritis. After forty-five years of age organic heart disease shows a higher rate than any other cause.

Among insured in the year 1923, it has been shown in one company that 12 per cent. of all policies paid on account of death are for heart disease and in one company alone equals $7,691,000. This figure must be multiplied many times, if the number of large life insurance companies is considered.

If one considers that every year of additional life for an adult means a net increase of $500 to the national wealth, one can build up a pretty sum in economic losses among insured lives; for, if the average age at death is fifty-six years, at which there is an expectancy of seventeen years, one readily shows a loss of at least $500,000,000 each year. Nor does this consider the sorrow and anguish or social losses of the many families broken and dissipated by the death.

That damaged hearts produce a larger toll of death than is directly charged is shown by a study[4] of influenza statistics, from which the inference is drawn that persons whose hearts were weak died when attacked by influenza, while others recovered.

From this brief résumé of the mortality statistics alone it is seen that heart disease is a very potent influence for ill in the national economic life.

Now what is the situation as to the living handicapped? It can be shown that for every death there are about ten individuals with damaged hearts to keep up the supply each year of deaths from this cause. Nor is it only by their deaths that these ten add to the economic loss, but from the gradual, progressive incapacity they are unable to maintain their standard productivity for months or years and, because of this failure, become an added financial and social burden to the family and, directly or indirectly, upon the community as a whole.

Among various groups considered as well—the children of the public schools, young adults of draft age, applicants for life insur-

[4] Raymond Pearl, Public Health Reports 1921, 35, pp. 273–389.

ance—it has been found that approximately two per hundred have hearts damaged by organic disease. It is a conservative statement and well within probability, therefore, to assert that in this country alone there are over two million people with organic heart disease. Of this over 600,000 are children of school age. From work done in the schools of New York it has been demonstrated that most of the children acquire the damage to the heart during the pre-school age and the cause of the damage is most closely associated with the infectious disease best called acute rheumatic fever.

From the data available in the special cardiac clinics of New York City and collected by the New York Heart Association, there was an average of approximately 6,000 individuals attending the out-patient clinics per month, making a total of 35,000 individual patient visits to these clinics in the year. The cost of this care estimated on the average cost per patient attending these dispensaries has been shown to be $23,561. It has been estimated, also, that a proper social service and medical follow-up with dispensary care approximately costs $15 per patient per year, or $88,500 for the group, if receiving adequate care.

From the records of ten hospitals in New York, the cardiac patient required 236,047 days, or 9.35 per cent. of all patient days at these hospitals, but represented only 4.58 per cent. of all patients. The total cost of the care of the patients in these ten hospitals was $607,280.

Those heart patients who were accepted in the convalescent homes cost for the year $156,591.

The total annual cost, therefore, for this one year group of heart patients who reach dispensaries, hospitals and convalescent homes mounts to the sum of $787,432 for one year. From what has been said it is obvious that this sum does not begin to express the total yearly cost of heart disease to the city of New York. If this is the incomplete bill of one city what must be the total cost each year of the care of patients with heart disease for all the cities throughout the United States and Canada?

In these few words we have touched on the losses from early death, from living physical incapacity and diminished productivity; from individual family and community expenditures on account of heart disease, and have shown the yearly sum of economic loss to be very great. The query naturally arises: What is being done and what can be done to decrease this waste of life?

Certain groups of interested persons of New York, Philadelphia, Boston, Chicago and other cities of the United States and Canada have organized and incorporated the American Heart Association for the purpose of making the problem of heart disease an absorb-

ing study. The members of that association recognize the enormity of the problem and that all organized agencies, groups and individuals must be informed of the complexity and intricacy of the problem and the part each must take in cooperation, if a solution is to be obtained. Thus, statistics must be gathered and analyzed by trained workers. Those interested in anatomy, evolution and eugenics must study the cause of defective development of the circulatory system. The student of heredity and hygiene must work upon the so-called degenerative diseases of the heart and arteries. The physiologist must discover the difficulties and interrelation of the internal secretions as they affect the heart. The bacteriologist and chemist must find the cause of rheumatism and the means of cure and prevention. The practicing physicians and clinicians must correlate the work of all and make from the mass of knowledge practical regulations for the improvement of the public health, which, then, may and must be applied by departments of health.

Certain things can be done at once by all persons—chief of which is the task for each person to have yearly at a stated period a complete physical examination by a competent physician. This has been demonstrated to be necessary in order that the presence and type of physical defect may be discovered early and before it gives symptoms; second, that the progress of old handicaps or development of new may be known; third, that advice as to type of occupation or need of change of occupation may be obtained as early as possible to prevent unnecessary incapacity and thereby prolong health, happiness, productivity and life.

Some of the larger insurance companies have already applied this annual stock-taking routine among their insured and have shown that over a period of five years the group had a 28 per cent. more favorable mortality as compared with the entire ordinary department for the same years and gave a return of two dollars for every one dollar expended. If the periodic medical examinations more than pay the companies how much more valuable must it be to the individual and to the community?

It has been shown[5] that by the application of the medical and sanitary knowledge now available the expectation of life in the United States could be advanced from fifty-eight to sixty-five years. What will follow the application of known facts to the prevention of heart defects can only be known by trying them out. To apply known methods of hygiene and sanitation requires wider distribution and dissemination of the knowledge to the professions, departments of health, educated persons and the less intelligent individuals of the population. Improved individual health must be made the

[5] Dr. L. I. Dublin, Harvey Lecture, December 16, 1922.

vogue! It is a matter of the greatest economic, industrial and social conservation, and the American Heart Association is planning to push the leadership in this work, define its objectives, assemble and interpret the basic facts and work out the principles of harmonizing conflicting interests until the public is aroused to such action that will effectively save lives. The more informed the public becomes, the higher will be the standards that will be demanded and the more adequate will be the provisions for public hygiene and sanitation.

Even among highly educated people there is sore need of more knowledge along these lines. Humanity must receive from the medical and scientific professions and from education more of the aid which they are capable of furnishing, and this can only be done by a great united public health effort.

It is the desire of this organization to plan soundly and wisely in this undertaking which must be of such great magnitude and there is offered an opportunity for the great national organizations of the scientific, trained men to assume the leadership in a movement which is quite as important as the problem of tuberculosis at one time was, but is now overshadowed by the much larger problem of heart disease. There is an opportunity to organize the best intellects of this country in various phases of a movement which must not be restricted to any one profession, for it is the business of every person to know his own value as a working machine.

It is this thought I desire to leave with you—heart disease as the leading single cause of death is causing huge economic losses. Such losses are in great measure preventable. An organization is available and desires the assistance of every organized body in the special work peculiar to it to the end that effective means may be applied to prevent and postpone death as well as to increase happiness and prolong life.

THE STATE OF SCIENCE IN 1924[1]

VERIFICATION OF THE THEORY OF RELATIVITY

By Sir FRANK DYSON, F.R.S.
ASTRONOMER ROYAL

In order to explain the transmission of the undulations of light across space, the existence of a medium called "ether" was assumed. This was supposed to possess properties such as rigidity and elasticity similar to those of matter. When it was found that electromagnetic oscillations (such as we now have in radio-telegraphy) were transmitted with the same velocity as light, the same all-pervading medium was naturally taken as their home.

Many noteworthy attempts have been made to determine by optical and electrical means the movement of the earth through this medium. They all gave negative results, and in explanation Einstein put forward in 1905 the restricted theory of relativity. This theory reviewed our fundamental ideas of time and space; it denied the existence of absolute space and absolute time, but regarded these as dependent on the observer. Einstein showed that a simple relationship held between the measures of space and time made by two observers moving uniformly with respect to each other. This theory was in harmony with the experimental results which had failed to discover the motion of the earth through the ether, and also accounted for the change of mass found by experiment in particles moving with very great velocities. In 1908 Einstein's theory was put in a clearer light by Minkowski, who introduced the idea of the *continuum*. Events take place in a four-dimensional *continuum* of space and time and not in a three-dimensional space and a wholly independent one-dimensional time. The relationship between the space and time of two observers moving relatively to one another was shown to be analogous to a rotation of axes in ordinary Euclidian geometry.

Einstein's Law of Gravitation

So far the theory of relativity had applied only to systems in uniform motion relatively to one another. Could it be extended to systems in which there is accelerated motion? In Newtonian dy-

[1] Prepared for the Hand-book to the Exhibit of Pure Science, arranged by the Royal Society for the British Empire Exhibition.

namics acceleration is attributed to force. Centrifugal force is regarded as a fictitious kind of force attributable to the rotation of the system of reference, but "gravitational" force as something inherent in matter. Is it possible to explain the latter by the properties of the *continuum?* By an extraordinarily brilliant piece of mathematical analysis, Einstein was led to formulate in 1915 a law of gravitation. In the neighborhood of matter the geometry of the *continuum* differed slightly from that of Euclid. It is not possible to visualize this, but it is analogous to the difference, in two-dimensional geometry, between the surface of a large sphere and a plane. The non-Euclidian properties of the *continuum* manifest themselves as a field of force. This can be illustrated in principle by the deflection of path undergone by a pedestrian who tries to walk in a straight course over the slope of a hill. The deflection is due to the geometrical properties of the slope which may be regarded as a non-Euclidian space of two dimensions.

Einstein's law of gravitation, though entirely different from Newton's in mathematical form as in the ideas from which it arose, gives results almost identical with those of Newton. This is its first merit, for Newton's law of the inverse square has been found sufficient to explain in great detail the movements of sun, moon and planets, procession of the equinoxes, the tides, the figure of the earth and many other phenomena. To the first order then, Einstein's law gives results identical with those of Newton. But there is one phenomenon which has puzzled astronomers since the time of Leverrier. The planet Mercury moves round the sun in an orbit which is, to a first approximation, an ellipse. But closer study shows that the position of this ellipse undergoes a change in the course of time, so that the point at which Mercury is nearest the sun (its perihelion) is not fixed, but is slowly revolving. The greater part of this revolution is duly explained by the attraction of the other planets, but a part is left over—only 40 seconds of arc a century—which had not been satisfactorily accounted for, although numerous hypotheses had been framed. Einstein's law of gravitation took this discrepancy in its stride and accounted for it exactly.

The Bending of Light Rays

This was an achievement which greatly enhanced the probability of Einstein's law being correct. He accordingly examined it to see if there were other phenomena which would follow from his law, but were not given by that of Newton. He found two. The first of these relates to the bending of light. If light in its journey to the earth from a star passes near the sun, it will be slightly de-

flected in its course, just as a particle of matter would be. He gave the exact amount of this deflection, which is greater the nearer the light passes by the sun. This prediction was verified at the total eclipse of the sun on May 29, 1919. British expeditions were sent to Brazil and to the West Coast of Africa to photograph the eclipsed sun. Seven photographs were taken which showed a number of stars. The observers in Brazil waited for two months, when they were able to photograph the same stars just before sunrise. The photographs were brought home and carefully measured. It was found that the relative positions of the stars had been slightly changed in accordance with Einstein's prediction.

The differences in the relative positions of the stars are, of course, not visible to the eye, as they are very minute. The largest displacement is only one third of the diameter of the star's image shown on the photograph.

The predicted amount of the bending of the light by the sun's gravitation for the stars shown on one of the photographs is compared in the following table with the amount actually observed:

Predicted	Observed
0.32″	0.20″
0.33	0.32
0.40	0.56
0.53	0.54
0.75	0.84
0.85	0.97
0.88	1.02

The observers in Africa were not so fortunate in weather conditions as those in Brazil, but they nevertheless succeeded in verifying Einstein's prediction. At the total solar eclipse of 1922 these results were confirmed by Canadian and Australian and still more by American astronomers.

Displacements in the Solar Spectrum

Another test which Einstein proposed for the verification of his theory is a slight displacement in position of the lines in the solar spectrum. The exact position of a line in a spectrum may be considered as measuring the time of some particular vibration in the atoms of the substance the light of which is being analyzed. According to the theory of relativity, the time of vibration of an atom in the sun will be lengthened slightly by the effect of gravitation. If, then, the position of the iron lines in the solar spectrum, due to iron vapor, for example, are compared with the position of those arising from the light of an electric arc with iron poles, they should be found to be shifted very slightly towards the red end of the spectrum.

The verification of this consequence of the theory of relativity was a matter of considerable difficulty, because there are many causes which produce slight displacements in spectral lines. Of these the effects due to possible movements of the solar gases were the most difficult to eliminate. Motion effects due to the sun's rotation and to the earth's rotation and varying distance from the sun are well understood, and could readily be allowed for. There was, however, a puzzling difference in the displacement in different parts of the sun's disc, the observed shift of the lines increasing from the center towards the solar limb, where it was found to be in excess of Einstein's prediction. To determine the cause of this involved measuring the shift in light coming from the hidden face of the sun, as reflected to us by the planet Venus when near superior conjunction (behind the sun). In addition to effects due to motion, the positions of spectrum lines depend to a small extent on the pressure and on the electrical conditions of the gas from which the light comes, also on the effects of anomalous refraction if the gases have an appreciable density. This complicated problem was attacked by several astronomers.

Mr. Evershed, the director of the Indian Observatory at Kodaikanal, made a very complete investigation. He found that the lines in the solar spectrum did, in fact, show a displacement, and he came to the conclusion that this displacement was for the greater part that predicted by Einstein, the disturbing effects, due to pressure, etc., being according to his researches negligible. His conclusion has since been confirmed by Dr. St. John, of the Mount Wilson Observatory, who has not only verified the relativity prediction, but has given an explanation of some shifts of the lines in excess of the Einstein effect. These residual effects had also been noticed by Evershed.

THE ORIGINS OF WIRELESS

By Sir RICHARD GLAZEBROOK, K.C.B., F.R.S.

In seeking the originators of radio-communication, the men who discovered electricity and investigated its fundamental properties are apt to be overshadowed by those who are concerned rather with the development of the art as we know it to-day. Many would be content to mention the names of Hertz, who in 1887 first produced and measured the wireless waves predicted twenty years earlier by Clerk Maxwell; of Lodge, who a year later showed at the Royal Institution some of its effects; of Marconi, whose inventions have done

so much to forward its practical use, and of Fleming, who first investigated the properties of the rectifying valve.

These are great names in the growth of radio-communication, but tribute should also be paid to those who made this growth possible. To find them we must go back many years, centuries in some cases, to investigators who, driven by their love of discovery and impelled by their thirst to know, sought, not to discover wireless telegraphy, but to improve our knowledge of nature and to bring under the realm of law and order some of the strange happenings which their search so led them to note.

Amber, found chiefly on the shores of the Baltic Sea, was much sought for in early days; recently an interesting dissertation on the trade routes of the ancient world has been written based on the dispersion of amber. About 600 B. C. it had reached Asia Minor, and Thales of Miletus is said to have been the first to observe its property of attracting light bodies to itself when rubbed. Thus we derive the name "electricity" from the Greek word for Amber.

It was probably at a later date than this that the curious property of a stone found in Magnesia was first noted, at any rate in the western world, when it was observed that if freely suspended it always set itself in a definite direction. It gained the name of the leading stone or loadstone, and this property formed the basis of the science of magnetism. Tradition tells us that the Chinese knew of this property centuries earlier.

Modern knowledge both of electricity and magnetism dates from Dr. Gilbert, of Colchester, physician to Queen Elizabeth, who in 1600 published his great and interesting work "De Magnete." Gilbert studied only electricity produced by friction; the electric current was still unknown, and for nearly 200 years remained unknown until Galvani, at Bologna in 1786, observed the convulsive shock produced in a frog's leg—at first when it was connected to a frictional electrical machine, and then in 1786 when two dissimilar metals, iron and copper, were placed in contact with nerve and muscle, respectively, and were then made to touch. His observations were continued and extended by Volta at Pavia, who showed in 1800 that the electricity originated at the contact of the metals. This led him to the discovery of the voltaic pile and the construction of an electric battery.

Various workers from Gilbert onwards had surmised that there must be some relation between electricity and magnetism. The verification of this is due to Oersted, professor at Copenhagen, who in 1820 showed that a wire carrying a current held near a magnet caused the magnet to move. Oersted's great discovery was at once repeated by Ampère in Paris, and he, by the aid of a few brilliant

fundamental experiments, discovered the laws which govern the mutual reaction between a current and a magnet. About the same time Faraday, at the Royal Institution in London, pursued the matter still further, and laid the foundations of the science of electromagnetism, the basis of all electrotechnical applications of to-day.

Meanwhile in Germany G. S. Ohm was at work. Volta had shown in 1880 that electrical force or "electromotive force" was produced in his battery, and that when the two metals which constitute its two poles are joined by a wire, a current of electricity flows round the circuit. It was left for Ohm to state the relation between the current, the electromotive force—or electrical pressure—producing it and the resistance of the circuit. Meanwhile, in America, Joseph Henry had during the same period discovered for himself many of the fundamental laws of electromagnetism.

These men, scattered throughout many lands, yet inspired by the same end—the improvement of natural knowledge—were the founders of modern electricity. When, therefore, some sixty years ago, a body of English men of science, led by Lord Kelvin, realized that the time had come to consolidate their knowledge into a system of accurate measurement, they found that new ideas needed definition, new units and standards required names, and with one consent they agreed to give to these standards the names of the great men whose labors through the centuries had wrested from nature the secret of electricity and magnetism. Thus we have the ohms and volts, amperes, henrys and farads which now form part of our daily language.

On the work of the men whose names are thus commemorated is based the discoveries of those brilliant workers who have made it possible to girdle the earth with a wireless chain depending on two or at most three great stations.

Foremost among those associated with modern developments is Clerk Maxwell, who in 1865 read before the Royal Society his paper on "The equations of the electromagnetic field." It was an attempt, which has stood the test of time, to apply mathematical reasoning to those principles, enunciated by Faraday, on which the construction of generators and motors, transformers and practically all electrical machinery is based. This reasoning led him to the result that the effect of changes in an electric current in a conducting wire would be propagated through space with a speed depending on the two constants, inductive capacity and magnetic permeability, which define the electric and magnetic conditions of the medium surrounding the wire. The values of these constants for air can be found from electrical considerations, and hence the velocity with

which electromagnetic disturbances are propagated can be calculated. To quote Maxwell's words: "We now proceed to investigate whether these properties of that which constitutes the electromagnetic field, deduced from electromagnetic phenomena alone, are sufficient to explain the propagation of light through the same substance," and his conclusion is: "The agreement of the results seems to show that light and magnetism are affections of the same substance, and that light is an electromagnetic disturbance propagated through the field according to electromagnetic laws."

Maxwell found that when the calculations were made the resulting value for the velocity was approximately equal to the velocity of light. The work was extended in his "Treatise on Electricity and Magnetism," published in 1873. The values of the velocity of light and the velocity of propagation of electromagnetic waves were not known then with present-day accuracy, and he concludes that they are quantities of the same order of magnitude. Present-day figures show that they are identical, and the electromagnetic theory of light is universally accepted. Nor was the result true only for propagation through air or interstellar space; such observations as were then available showed that, in all probability, it held for all transparent media, though there were discrepancies, known now to be due to dispersion, which required explanation. But there was a wide gap between this theoretical deduction of Maxwell and the wireless telegraphy of to-day, which needed many more investigations in "pure" science before the bridge was complete. No one had received electromagnetic vibrations—at any rate, to his certain knowledge. The method of generating them and the means for measuring them were still to come.

For the former we have to go back to a remarkable paper of 1853 by Lord Kelvin. Helmholtz seems to have been the first to conceive that the discharge of a condenser through a wire might consist of a forward and backward motion of electricity between the coatings—a series of currents in opposite directions. Lord Kelvin took up the question mathematically and investigated the phenomena. He showed that, under certain conditions, there would be oscillations of periodic time $2\pi\sqrt{LC}$, where L is the inductance of the coil, and C the capacity of the condenser. These oscillations must, according to the theory, give rise to waves traveling out into space with the electromagnetic velocity. Fitzgerald had predicted in 1883 that they might be produced by utilizing the oscillatory discharge of a Leyden jar, and Sir Oliver Lodge in 1887 produced and detected them. For their detection the principle of resonance was employed. Any mechanical system free to vibrate has its own period of oscillation, and the application to it of a series of small impulses at inter-

vals coincident with the free period of the system results in a disturbance of large amplitude. So, too, an electric system having capacity and inductance has its own period of electrical oscillation, and, if this coincides with the period of incoming electrical waves, electrical disturbances of a magnitude which can be detected by our apparatus are set up. It is necessary that the receiver and the transmitter should be in tune. Lodge made use of this principle, and, by receiving the waves on wires adjusted to resonance with his Leyden jar and coil, was able to detect them. David Hughes, working in the early eighties, had already detected such oscillations, but was discouraged from pursuing the subject.

In 1879, in consequence of the offer of a prize by the Berlin Academy, the attention of Heinrich Hertz, then a student under Helmholtz, was attracted to the problem of electric oscillations and their detection. He came to the conclusion that with the means of observation then at his disposal "any decided effect could scarcely be hoped for, but only an action lying just within the limits of observation." The investigation was laid aside, only to be revived in 1886 by a chance observation of the effect of resonance in two circuits which happened to be in tune, and his realization of the fact that herein lay the means of solution of his problem. His paper "On very rapid electrical oscillations" appeared in 1887, and from this experiment came verification of Maxwell's theory, the basis of all our knowledge of wireless.

Fitzgerald directed the attention of English physicists to the work at the British Association meeting in 1888, and Lodge exhibited many of the effects of the waves at the Royal Institution in 1889. The investigations which led to such brilliant results were inspired by the desire for knowledge; the idea of their practical application was entirely absent. Signalling by wireless waves was not foreshadowed until Crookes suggested it in 1892, and in 1893 Lodge heard of Branly's coherer and applied it to the rectification and reception of wireless waves. From this started the investigations of many of those whose names as pioneers are familiar to all. But another discovery in pure science was necessary to complete the work.

Edison had shown in 1883 that if an insulated electrode is inserted in an ordinary glow lamp there is a current of negative electricity from the filament to the electrode, and Fleming made some observations about that date on the Edison effect. In 1904 he applied them to produce a valve rectifier for high-frequency oscillations by connecting one pole of his receiving circuit to an insulated plate or cylinder within a carbon lamp, of which the negative electrode formed the other pole of the receiving circuit.

Dr. Lee de Forest improved this oscillation valve a little later, making it an amplifier as well as a rectifier by placing between the filament and the plate or cylinder a grid of metal wire connected to an external source of electromotive force. There is ordinarily a current of negative electricity passing from the filament to the plate —the plate current it is called—through the interstices of the grid. By varying the potential of the grid this current can be varied, and the conditions can be so adjusted that small changes in the potential of the grid will produce large changes in the plate current. The grid is connected to one pole of the circuit receiving the incoming waves, and the small variations of potential which they produce thus give rise to large variations of the plate current which can be made to actuate a telephone and thus to produce audible sounds. By placing a number of valves in series, very large amplifications are possible.

The other uses of the valve are numerous. It is employed as a transmitter for wireless work, while it finds many applications as a source, or rather regulator, of vibrations of comparatively short period. The post office has used it as an amplifier of speech, while Mr. F. E. Smith has applied it as a source of sound in connection with the measurement of audibility.

The whole of this arose from Edison's observation of the discharge of negative electricity from the heated filament, but its development may be said to have been dependent on another and more fundamental discovery about 1897—that of the existence of the electron, the ultimate entity in electricity, which we owe to Sir J. J. Thomson.

Before the introduction of the oscillation or thermionic valve, as it is sometimes termed, radio-communication was in practice confined to telegraphy. Signals were sent out and received which were interpreted by the use of the Morse code. The advent of the thermionic valve has made wireless telephony, with its recent remarkable development in the form of broadcasting, a practical proposition and a factor of interest in the lives of innumerable people.

THE PHYSICAL BASIS OF DISEASE

VIII. THE DIAGNOSIS OF DISEASE

By THE RESEARCH WORKER
STANFORD UNIVERSITY

A WEEK later the research worker received a note from the manufacturer:

We're at the St. Francis. Can you dine with us Wednesday? Want you to meet the wife. She's interested in your dope.

"I've been so disappointed in doctors," said "the wife" as they entered the dining room Wednesday evening. "They don't understand my case. Dr. Levison said I was anemic. He gave me some medicine, but it didn't do any good. Dr. Blanchard recommended a milder climate. So I came to California; but the climate here doesn't seem to" ———

"Now, Mary," said the manufacturer, "just give me time to order. How about mulligatawny soup? The doctor here ———

"But, you know I can't eat those rich soups."

"Right. Two mulligatawnys, one bouillon."

"My relatives in San Diego took me to Dr. Morello. He found my trouble. The nerve going to the endocrine gland was squeezed. He adjusted my spine, and I was better for a time, but my trouble came back. Then I tried the latest electrical cure. Dr. Langley. He found beginning cancer in my kidneys. He cured this in a few weeks. Lately, I've been eating this new health food. What else is there to try?"

"Why not try a competent medical diagnosis?" said the research worker.

"But I've had a dozen diagnoses."

"You've consulted a dozen practitioners. Various types, various schools. To say the least, the majority of them were frankly incompetent. Do you know the chances of obtaining competent medical advice in California, at the present time? California has nearly 15,000 practitioners. Less than a third of them have ever dissected a human body, or, for that matter, have even seen such a dissection. The chances are two to one that a stranger who doesn't know the ropes will fall into the hands of a man wholly incompetent to determine the nature of his disease."

"A commercial detriment to California," said the manufacturer.

"Conditions here are but little worse than in other parts of the country."

"Then what can be the matter with me?" asked the wife.

"I haven't the least idea. For all I know, you may have a beginning cancer, as Dr. Langley said, that will kill you in six months, in spite of everything science can do."

"Are you serious?"

"Or you may have merely a psychical upset of your organs, because you were not elected president of your woman's club."

"How'd you know I was a candidate?" asked the wife.

"You have a vacuum cleaner at home?"

"The latest model."

"When it gets out of order, I suppose the janitor can easily fix it?"

"Oh, I wouldn't trust him. I telephone the agent."

"In other words, you insist on a competent mechanic to diagnose and treat your vacuum cleaner. Yet you trust your body to any jack-of-all-trades who offers his service. You will excuse me for being uncomplimentary, but it's people of your type, people of means and social position, who're responsible for the commercial exploitation of the medically ignorant. Without your endorsement and support the exploitation would not be profitable."

2

"How did Dr. Morello make his diagnosis?" continued the research worker.

"Wonderful! Soon's I entered his office he said, 'Don't tell me a thing!' Then he looked right through me. 'Endocrine deficiency! Leakage of nerve force! Seventh lumbar!' or something like that. Marvelous!"

"And you fell for such bunk! It's one of our unfortunate heritages from the past, to regard physicians as magicians, with specially developed diagnostic instincts or psychical powers. You don't expect such a thing of an automobile mechanic. You expect him to act like a rational human being. You tell him your trouble. He tests wires, batteries and flow of gas, tries for unusual friction or unusual play of parts, locates the trouble by collecting facts and making logical deductions from these facts. An experienced mechanic may locate trouble quickly. An expert may find trouble overlooked by others. But even the expert claims no special trouble-locating instinct of psychical power.

"The diagnosis of human disease is exactly the same process. Careful examination, logical reasoning. Some physicians are more expert than others. But a physician who makes a grandstand play of his psychical powers of diagnostic instincts can be put down at once as a charlatan interested only in selling himself to his patients.

I care not to what school of medicine he belongs, nor what his standing or previous training."

"We've the same type to deal with in our factory," said the manufacturer. "We weed 'em out p.d.q."

"Probably the most serious criticism of the medical profession to-day is the lack of efficient mechanism for the similar weeding out of incompetents. A young man who passes the elementary state board examination is licensed for life. Within certain limits, he can adopt almost any method of commercial exploitation and be free from legal interference. The dangerous charlatan is not the untrained nature-curist or religious fanatic, but the regularly licensed physician of predatory instincts."

"What percentage of physicians are of that type?" asked the manufacturer.

"Remarkably small percentage, considering the lack of legal control. I believe the predatory instinct is less in evidence among physicians than in any other profession. There are those, however, who deliberately choose medicine as their field of exploitation, deliberately prepare for such a career. A state board examination doesn't test character."

"I should think the public would soon get on to such a doctor."

"The public is often his ardent champion. Let's suppose you, a regularly licensed physician, deliberately plan a career of commercial exploitation. The big money is in a successful new cult. In a popular magazine you find an account of the newer conceptions of atomic structure. Each atom a minute solar system. Central sun, revolving satellites, electrically charged meteors shooting off into space. Strong appeal to popular imagination. You have found your cult. In health the atomic satellites revolve at normal speed. Increase or decrease this speed and you have disease. 'Sick atoms.' The public will fall for it. Each disease has its own atomic rotation. Cancer, tuberculosis, syphilis can thus be quickly diagnosed by electrical tests. The connection between rotation and electricity is not very clear to you, but the public will never notice. Atomic rotation can be hastened or slowed by electricity. Cancer, tuberculosis, syphilis cured."

"The first competent chemist will show this to be nonsense," said the manufacturer.

"The newer conception of atomic structure is not an established fact. No physical-chemist claims it to be. Merely a graphical representation of atomic properties as at present understood. A new fact, to-morrow, may modify this graphical picture. It would take an expert physical-chemist years to disprove your claims.

Meanwhile, your neurotic patients are singing your praise, your machines for electrical diagnosis and electrical regulation of atomic rotation are selling to hundreds of predatory physicians. You may even be fortunate enough to be arrested for fraud. At trial you state under oath that in your opinion your conception of disease is correct. Eminent pathologists state under oath that in their opinion your conception is wrong. A difference of opinion between legally qualified physicians. No jury will convict on such evidence. The publicity doubles your sales."

"A fanciful picture," said the manufacturer.

"Exactly the game the late Abrams was putting over in this city. I am told on what I believe to be reliable authority that at the time of his death he was clearing nearly twenty thousand dollars a month with this scheme. I don't know that this was a deliberate fraud on Abrams' part. It's more charitable to assume it was the irresponsible action of an insane man. There's no adequate method of controlling an insane physician. Many a physician has continued practice till the day before he was committed to an asylum. The same is true of the physician who becomes an irresponsible drug addict."

"A quarter of a million a year," said the manufacturer. "We don't clear that in our Pittsburgh branch. That branch employs over a thousand men."

" 'Chicken feed' compared with the sums taken in by the bigger medical fakes. Luckily, the success of such a fake often depends on the personality of its originator. I am told the income of Abrams' institute decreased 90 per cent. within two months after his death. I've no doubt if Abrams had lived his aggressive personality would have won political support. A special board would have been created for the independent licensing of atomopathic physicians."

"Nonsense," said the manufacturer.

"Independent boards already exist in several states to license equally absurd medical fakirs."

"These alleged fakirs must make cures," said the manufacturer. "Otherwise, they couldn't continue in practice."

"Then fake oil stock must always earn a fair dividend or it wouldn't sell. There is one born every minute."

3

"But we're getting away from our original topic. The diagnosis of disease. There is no special diagnostic instinct or psychical power, no magic divining rod. Diagnosis is exactly the same as

locating trouble in an automobile. A competent physician relies solely on logical deductions from determined facts, with careful weighing of possibilities and probabilities.

"I wonder if you realize the difficulties in such diagnosis. There's hardly a symptom that may not be due to half a dozen different causes. Few symptoms that can not be merely subjective sensations of psychical origin. The physician must base his judgment mainly on objective data obtained by himself or by competent assistants."

"But doctors treat disease by mail," said the manufacturer.

"No competent physician will attempt a diagnosis solely on the basis of a patient's account of his symptoms. In emergency, a physician may prescribe. He knows he's taking a shot in the dark in doing so. Mail-order diagnosis is a common form of commercial exploitation. Often used to sell proprietary products.

"In the first place, serious, even fatal disease may exist and the patient be conscious of no localizing symptoms. Take liver abscess. Local death of liver tissue with local accumulation of pus. One of the most serious diseases. Rupture of the abscess often occurs into the heart sac, lungs or abdominal cavity. If unrelieved by surgical means, in nine cases out of ten the patient will be dead in three weeks.

"The liver, as you know, is almost devoid of sensation. Operations may be performed by merely anesthetizing the overlying skin. A liver abscess, therefore, may give no localizing sensation. The patient complains of fever, loss of appetite, occasional chills or sweats. I defy the most skilled physician to diagnose liver abscess from these data. The mail-order physician prescribes for malaria."

4

"As the disease advances, the patient may become conscious of localizing pain or discomfort. This pain is usually misleading. We are here up against the common phenomenon of referred pain. Sensations arising in one part of the body, projected in consciousness to some other part. Pain from liver abscess is usually first felt in the right shoulder. The mail-order physician prescribes for rheumatism. The chiropractor massages the back of the neck. A religio-therapeutist recommends some ritual. A competent diagnostician inserts a hollow needle into the right side and draws off a pint of pus."

"I have frequent pain in my right shoulder," said the wife.

"Yes. But your pains often jump to the left shoulder."

"You're clairvoyant?"

"Merely a guess. I've been collecting objective data from you since we sat down."

"Liver abscess must be unusually difficult," said the manufacturer.

"Typical of difficulties often met. Another illustration. Tuberculosis of the spine. The bones, as you know, are relatively nonsensitive. They are a frequent seat of tuberculous infection. The center of one of the backbones may be completely liquefied or digested by tuberculosis, and the patient be conscious of no localizing sensations. Slight fever, fatigue or exertions, loss of appetite, symptoms that might arise from a dozen different causes.

"As the disease advances, localizing symptoms appear. They are often misleading. Pain referred to the knees or legs. Objective signs even may appear first at the knees. Connected with the backbone are long muscles passing down through the pelvis to the legs. Some of these muscles go to the knees. Tuberculous liquid may ooze out of the backbone into a muscle sheath and trickle down this muscle to the knee. The pus may accumulate at the knee in large quantities, puffing out the tissues. Or it may erode the skin at the knee, giving a constant tuberculous discharge. The open sore at the knee doesn't heal on the application of antiseptics. An incompetent surgeon may amputate the leg for incurable joint disease. A number of such amputations are on record. As the disease advances, localizing symptoms appear in the back, making diagnosis easy."

5

"Amputate his leg! Are such mistakes common?" asked the manufacturer.

"There is no way of knowing the percentage of error in diagnosis in private practice. The probable percentage has been determined, however, for hospital physicians. This was done by comparing their diagnoses with subsequent autopsy findings. It was found in one hospital, for example, that the diagnoses agreed exactly with the autopsy findings in 50 per cent. of the cases. Agreed with sufficient exactness to introduce no error in treatment, in 25 per cent. Twenty-five per cent. of the diagnoses were wrong."

"I surely thought doctors had a higher batting average than that," said the manufacturer.

"The percentage of correct diagnoses is of course often higher than this. With adequate clinical facilities, a conscientious, competent physician can correctly diagnose pulmonary tuberculosis, for example, in at least 97 per cent. of the cases; syphilis and typhoid

fever in fully 94 per cent. There is always, however, an appreciable error even with the most perfect methods."

"You're speaking of experts," said the manufacturer. "How about the common or garden variety of doctor?"

"The average error is unknown. Autopsies are too infrequent in private practice. If every death were followed by an autopsy by an impartial pathologist, incompetent diagnosticians would be driven out of business in a few months.

"The diagnostic errors with certain types of physicians, however, and with certain diagnostic methods, are fairly well known. Data have been collected, for example, of errors by Abrams' electronic method. Numerous patients diagnosed by this method have subsequently come to autopsy. A diagnosis of syphilis with the patient dying of unsuspected cancer of the stomach, a diagnosis of cancer with death from unrecognized heart disease, a diagnosis of tuberculosis with the patient accidentally killed showing normal organs, are typical. If the diagnoses were drawn blindfolded from a hat, the percentage of error would not be greater.

"Probably the most extensive data have been collected regarding the diagnostic error by religio-therapeutists. Diagnosis of cancer by Christian Scientists, for example. Hundreds of their cancer diagnoses have been investigated. In fully 95 per cent. of the cases in which concurrent medical examination was possible, or subsequent autopsy records available, there was no reason to suspect cancer. A neurotic individual with constipation, a woman with a cracked nipple, are typical examples. In only about 3 per cent. of their cases was cancer found. A diagnostic error of 97 per cent."

"Shall we adjourn to our rooms?" asked the manufacturer, as he signed the waiter's slip.

THE HISTORICAL DEVELOPMENT OF SURGICAL ANESTHESIA

By Professor CHAUNCEY D. LEAKE
UNIVERSITY OF WISCONSIN

THE fundamental aim of medical art and science is, and always has been, the alleviation of human pain and suffering. In no field of medical endeavor has this aim been so satisfactorily achieved as in the development of surgical anesthesia. This is not so remarkable in view of the fact that submission to surgical procedures involves the conscious anticipation of pain and distress far greater than that usually realized in accidents or ordinary sickness. The development of anesthesia from an empirical basis to a firm rational foundation has been one of the greatest achievements of science, and it provides one of the most interesting stories incidental to the growth of knowledge.

Anesthesia may be accomplished in two ways. The bringing about of unconsciousness with general loss of sensation, including of course the sensation of pain, is general anesthesia. On the other hand, the application of an agent to a particular local area of the body, to abolish the sensation of pain in that area, is local anesthesia. It is interesting that local anesthesia was undoubtedly the first type of anesthesia to be used empirically, and it is also the form of anesthesia in which the greater scientific interest lies at the present time.

THE DEVELOPMENT OF LOCAL ANESTHESIA

It is well known that pressure applied to a nerve trunk or artery, particularly along an arm or a leg, will cause the disappearance of sensibility in the area below that on which the pressure is applied. It is this which results in our feet or hands "falling asleep." Many primitive people use pressure in this manner to achieve local anesthesia. At the dawn of civilization this form of anesthesia was practiced, as is shown by the Egyptian carvings illustrating the method. These carvings were discovered on the door-post to a tomb excavated by Loret in the Necropolis of Saqquarah, and they have been dated at 2500 B. C. It must be confessed that only mental suggestion of some sort could make pressure upon an arm effective in producing anesthesia in a leg, in the case of one of the figures, but this particular carving was apparently for the purpose of illustrating how the anesthesia was obtained and not to illustrate an actual operation.

—*From Holmes and Kittermann*

EGYPTIAN CARVINGS

Circa 2500 B. C., illustrating how anesthesia may be produced by means of pressure.

Among the early Assyrians pressure was used on blood vessels to give anesthesia in the customary operation of circumcision. During the Greek and Roman periods, this type of anesthesia apparently was not practiced. It was revived, however, in the early part of the seventeenth century by Valverdi, and again by James Moore in 1784. The latter suggested applying pressure by clamps to the nerves supplying the part to be operated upon, but, as the great surgeon Hunter demonstrated, the plan was impractical.

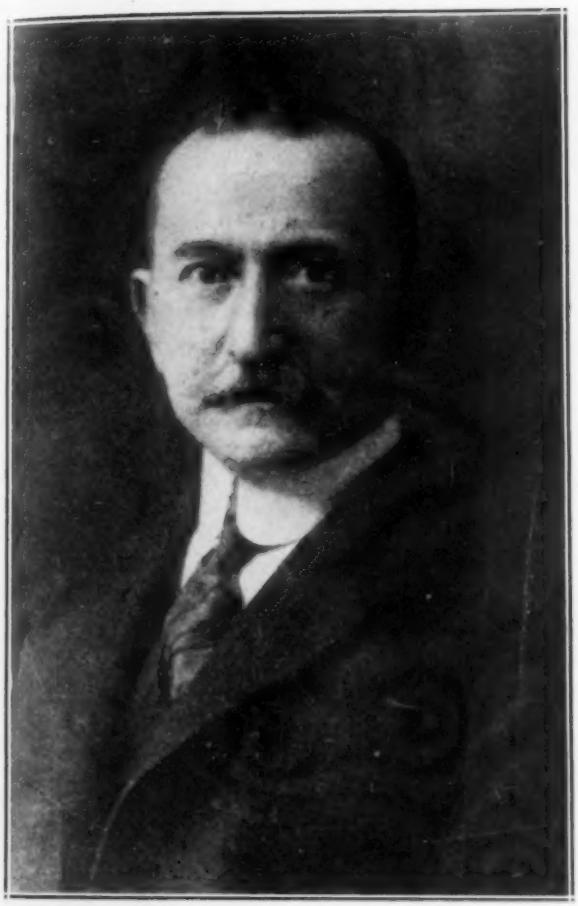
Many other kinds of local anesthesia have been followed until the modern era of cocaine and its derivatives. Dioscorides in the first century A. D. discusses the local application of preparations of mandragora and other atropine-containing plants for the relief of pain. Atropine does somewhat deaden the sensory nerve endings, and various concoctions of plants containing it were used for centuries as local anesthetics. Opium preparations were also applied locally for the same purpose. In 1773, Thomas Percival (1740–1804), who wrote the first "Code of medical ethics," de-

scribed in an essay "On the medicinal uses of fixed air" the properties of carbon dioxide in relieving the pain of raw wounds, when blown against the denuded surfaces. The first carefully conducted experiments with the object of securing local anesthesia were made by Sir Benjamin Ward Richardson (1828–1900), who did so much to place the entire matter of anesthesia upon a scientific basis. He noted the anesthetic effects of cold applied locally and studied the effects of rapid evaporation of volatile liquids in producing cold at a given spot on the skin. In 1867, he introduced what has been termed the Richardson ether spray, for the purpose of producing a satisfactory local anesthesia, and this method was in general use

—*From Moodie*

ARTIST'S RECONSTRUCTION OF PRIMITIVE SURGERY AMONG THE PERUVIAN INCAS

The operator chewed cocoa leaves, permitting the saliva to flow on the wound to induce anesthesia.



—*From a photograph*

DR. CARL KOLLER

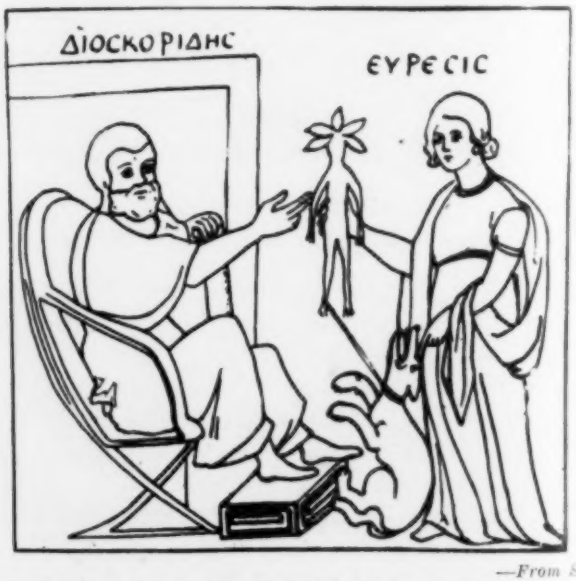
Who demonstrated the local anesthetic properties of cocaine.

for many years. It was later modified by the use of ethyl chloride, a substance which evaporates more quickly than ether, and hence leads to the desired result more effectively.

Local anesthesia was established upon a firm basis with the demonstration of the local anesthetic properties of cocaine. The aboriginal inhabitants of the highlands of South America were acquainted with these properties. Dr. Roy L. Moodie has reconstructed an early surgical operation among the Incas, showing a blanket clad shaman using the cautery to make a cruciform incision in the scalp of a woman suffering from melancholia. The operator chewed a cud of cocoa leaves, the juice from which he could drop upon the wound if the pain became severe.

The steps in the introduction of cocaine as a local anesthetic were many. Alexander Wood, in 1853, introduced the hypodermic syringe, without which the administration of cocaine or its derivatives would be difficult. Albert Niemann, in 1858, isolated cocaine from cocoa leaves, while working in the laboratory of Friedrich Woehler, and both Niemann and Woehler described the numbing effect of the alkaloid upon the tongue, without recognizing the significance of this fact. Cocaine remained a curiosity for many years. In 1880 a British medical commission learnedly reported that the substance had no medical value, being at best merely a poor substitute for caffein. This same year, Von Anrep published a careful pharmacological study of the alkaloid, in which the local anesthetic properties were hinted at, but it remained for Dr. Carl Koller actually to demonstrate its great value.

Due, perhaps, to his own charming modesty, Dr. Koller has not generally received the full credit that he deserves for his demonstration of the local anesthetic properties of cocaine. It may be of interest to give such facts in the matter as are available. Carl Koller was born in Schuettenhafen, Bohemia, on December 3, 1857. He graduated from the University of Vienna in 1882 and interned at the Allgemeines Krankenhaus. From 1885 to 1887 he was assistant to Snellen and Donders at Utrecht, Holland, and then came to New York City in May, 1888. He has since continued most suc-



—*From Singer*

THE GODDESS DISCOVERY PRESENTING MANDRAGORA TO DIOSCORIDES

Preparations of this plant were used as anesthetics in Roman and medieval periods.

—*From an engraving*

VALERIUS CORDUS

Who first described the synthesis and properties of ether, about 1540 A. D.

cessfully (a fact to which I may personally testify) in the practice of ophthalmology in New York. Dr. Emil Mayer, chairman of the Committee on Local Anesthesia for the American Medical Association, in a report published in the *Journal of the American Medical Association* in 1920, presents Dr. Koller's story of his discovery of the local anesthetic powers of cocaine. Up to the year 1884, the only satisfactory method of local anesthesia was Richardson's ether spray, which was not suitable for eye work. Koller tried unsuccessfully to find some way to achieve local anesthesia in eye surgery, and gave up the attempt when his friend, Dr. Sigmund Freud, of psychoanalytic fame, enlisted his aid in studying the physiological effects of cocaine taken internally. Dr. Koller noted the benumbing effect of cocaine on the tongue, as had other workers with the drug since the date of its discovery. It occurred to Koller, however, that here might be the agent for which he was seeking in connection with eye anesthesia. Experiments in Strickler's laboratory in Vienna on animals and normal humans convinced him of the importance of his finding, and he made his first report to the German Ophthal-

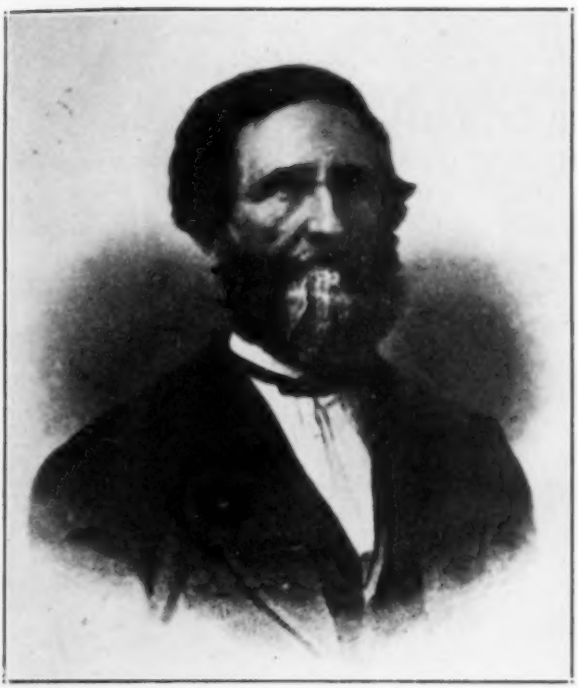
mological Society at Heidelberg on September 15, 1884, through the agency of Dr. Brettauer, of Trieste. Later, he published a paper on the subject in the *Wiener Medizinische Wochenschrift*, which was immediately translated into important medical publications abroad, and within a year the new procedure was in use all over the world. In fact, so quickly did the importance of the discovery become common knowledge that in 1885 Dr. James L. Corning, of New York, had already demonstrated hypodermic and spinal anesthesia with the use of cocaine solutions.

Recent progress in the exact knowledge of local anesthetics, together with the scientific study of their toxicity and therapeutic values, has been greatly facilitated by the appointment of committees for their appraisal in both England and the United States. The field has proven a fertile one for the synthesis of chemical relatives of cocaine, and scarcely a year has passed since Koller's discovery without the announcement of a new local anesthetic agent. The most valuable method of inducing local anesthesia, through infiltration, was introduced by C. L. Schleich in 1894, while the most satisfactory and least toxic of all the substitutes for cocaine was introduced by the chemist Alfred Einhorn, and the clinician, Dr. H. Braun, in Germany, as novocaine or procaine, in 1905. Braun also introduced the use of epinephrin with local anesthetic agents in order to delay absorption and check bleeding. Recently, Dr. Roger

—*From Hollander*

A CARTOON BY GILRAY (1802)

On the experiments of Davy at the Pneumatic Institute. Davy holds the bellows.



CRAWFORD W. LONG
Who first used ether as an anesthetic on March 30, 1842.

Adams, in this country, has furnished the chief scientific background for the commercial exploitation of "butyn," a substance claimed to have great therapeutic value, especially in eye surgery, but which has been shown to be very toxic. Dr. A. S. Loevenhart and Dr. H. L. Schmitz have still more recently suggested "isocaine," a substance chemically related to procaine and to butyn which combines all the advantages of procaine for infiltration work and of cocaine for eye surgery, and which is not as toxic as cocaine or butyn.

The story of the development of local anesthesia, while not as interesting or as lengthy as that of the growth of general anesthesia, is of great importance, because it is quite generally recognized that local anesthesia represents the most satisfactory type of anesthesia, as far as effects upon the patient are concerned, and if the patient's confidence and cooperation can be secured, in the general conduct and expense of the operation. Local anesthesia has been one of the most important factors in the development of modern highly specialized surgery. As our knowledge of the relation between constitution and action of the various local anesthetic agents becomes

more perfect, we may be in a position to synthesize a more ideal local anesthetic, one with high therapeutic efficiency, low toxicity and lasting action.

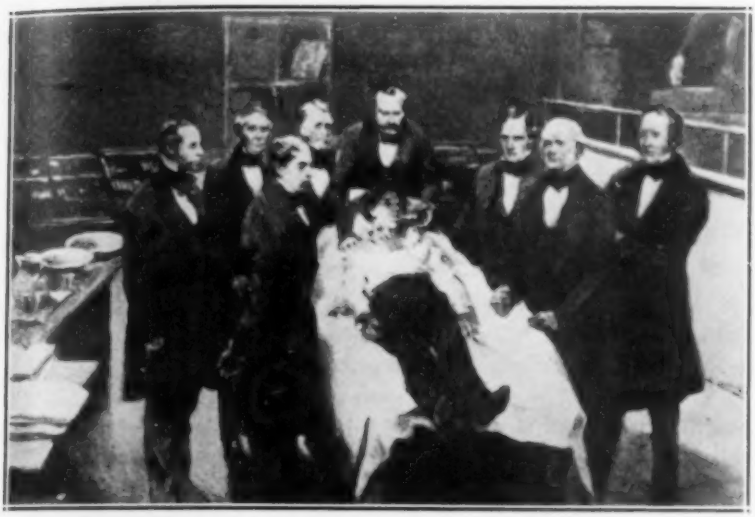
The Growth of General Anesthesia

General anesthesia seems to have been practiced as anciently as local anesthesia, for references to it occur in the Bible and in Homer. Among the most primitive methods of inducing general anesthesia was the stoppage of blood flow to the brain and the consequent cause of fainting, by blocking the carotid arteries by pressure. In both Greek and Russian, these arteries are called the "arteries of sleep." It may be that the "temple sleep" induced in the Asclepieia, or health resorts of Ancient Greece and Rome, was some sort of hypnotic anesthesia practiced for the purpose of allevi-

—*From Truman Smith*

HORACE WELLS

Who first used nitrous oxide as an anesthetic in 1844.



—*From an engraving*

THE FIRST PUBLIC DEMONSTRATION OF SURGICAL ANESTHESIA
Massachusetts General Hospital, Boston, October 16, 1846.

ating pain and anxiety. Hypnotism was revived in the eighteenth century for anesthetic purposes, but without success.

There is every evidence that the early Chinese and Egyptians were familiar with the pain-relieving properties of opium and of Indian hemp. Herodotus gives the first reference to inhalation anesthesia when he describes how the Scythians inhaled the fumes from hemp preparations before submitting to surgical operations. A Chinese manuscript has been found which gives the formula for a hemp mixture which when given to patients renders them insensible to pain during operations.

The most important of the ancient anesthetic agents, however, was mandragora, about which a voluminous mythology arose. Just what atropine-containing plant the ancient mandragora was has not been definitely determined, for there are many members of the order Solanaceae (the potato family) from which choice could be made. Moreover, many of these plants contain other potent alkaloids, among them scopolamine and hyoscyamine, which have sleep-producing and analgesic powers.

The ancient use of mandragora as an anesthetic agent was well described by Pedacius Dioscorides, a Greek army surgeon in the service of Nero, 54–68 A. D., and this description was later copied by Pliny. Dioscorides is the authoritative source for the materia medica of the ancients, describing, as he did, the medicinal use of some 600 plants. His work was the basis for the therapeutic prac-

tices of physicians until the 16th century. In the 65th chapter of the fourth book of Dioscorides, as well as in other places, direct mention is made of the use of preparations of mandragora to produce insensibility before operations or the use of the cautery:

> Aliqui radices in vino ad tertias coquunt, & defaecatum ius feruat, cyathoque uno utuntur, in peruigiliis, & doloribus, & ante sectiones ustionesque, ne sentiantur.

So greatly did the properties of mandragora impress the popular mind that it was endowed with supernatural powers. It was supposed to have been brought to the attention of Dioscorides by the goddess Discovery, who, in accordance with the popular belief, had to sacrifice a dog while gathering the herb.

Variations of this mandragora anesthetic of Dioscorides were used in Europe all through the Middle Ages. By the 13th century

—*From Gwathmey*

CHARLES T. JACKSON

Who tried to patent ether with Morton.

ON THE

PHYSIOLOGICAL EFFECTS

SULPHURIC ETHER,

SUPERIORITY TO CHLOROFORM

BY WILLIAM T G MORTON M.D.

BOSTON

—*From the original*

TITLE-PAGE TO MORTON'S FIRST PUBLICATION ON ETHER

opium preparations began to supplant the earlier atropine concoctions, and for a while the two were used together in the "spongia somnifera" of Hugo de Lucca. Juices of poppy and mandragora, together with various other plants, were boiled with a sponge, which was then dried to be used as needed, by soaking with hot water and applying to the nostrils. In 1589, Giambatista Porta used a similar preparation boiled in a lead vessel with a lid, which could be raised so that the fumes might be inhaled. Owing to the uncertainties of action of these agencies, however, and because of the fatalities incurred, they quickly fell into disuse, and as early as 1543 Ambrose Paré, the great French surgeon, had discarded them to return to pressure applied locally for anesthetic effects.

A large factor in the gradual abandonment of atropine anesthetics was the recognition that opium preparations were far superior in relieving pain and anxiety. The work of Paracelsus (1493–1541) in introducing alcoholic tinctures of opium did much to displace mandragora and belladonna as the anesthetics of choice. Laudanum and similar opium preparations were used to allay pain and distress in surgical operations from the time of Paracelsus to the advent of ether anesthesia in 1846.

It is remarkable that ether itself was discovered about 1540, and there is some evidence that the great Paracelsus himself was acquainted with its anesthetic properties. Ether was first described by Valerius Cordus (1515–1544), who in his brief span of twenty-nine years gave Europe its first Pharmacopeia, inaugurated the systematic study of botany, and was a pioneer in turning from the vain efforts of alchemy to the rational aims of chemistry. The third part of his "De Extractione" contains the earliest known account of the synthesis of *oleum dulci vitrioli* (diethyl oxide) from the distillation of "very biting wine" or alcohol and "sour oil of vitriol" or sulphuric acid. The care with which Cordus gives his method and prescribes his standards of purity for his reagents stamps him as a modern in chemical procedures. He found that ether evaporated very rapidly and that it was an excellent solvent for many substances. Being primarily interested in the treatment of disease, he noted that ether promotes a copious flow of saliva and that it relieves hacking coughs and bronchial irritations. These observations are of great interest, because it was probably from the use of ether for these conditions in the early nineteenth century that the anesthetic powers of the substance were finally discovered. Paracelsus, who was a contemporary of Cordus, may have been familiar with the "sweet oil of vitriol," for he refers to an extract of vitriol which had an agreeable taste, put animals to sleep without injury and which had remarkable powers in relieving pain.

By the middle of the 18th century the spirit of critical skepticism was contributing again to a new development of rational medicine. With regard to the problem of anesthesia, this was manifested by the critical investigations of Anton Stoerck (1731–1803) of the "Old Vienna School," on the action of stramonium, hyoscyamus and other atropine-containing plants. He could find little basis for their use as analgesic agents.

The rise of modern inhalation anesthesia may be traced to the interest in the gaseous elements and their effects on respiration. Joseph Priestley (1733–1804), that interesting clergyman who was forced to flee from England to a mountain home in Pennsylvania, isolated oxygen and discovered nitrous oxide in 1772. The real credit for the discovery of oxygen, however, should be given to Lavoisier (1743–1793) and his wife, because their introduction of quantitative methods in chemistry made them realize its great significance. Oxygen and the phenomena of oxidation in the living body are of supreme importance to anesthesia, since they may be concerned with the fundamental explanation of the conditions.

The realization of the significance of oxygen had a singular effect upon medicine. Many theories of disease were formulated on

A

MANUAL OF ETHERIZATION:

CONTAINING DIRECTIONS FOR THE EMPLOYMENT OF

ETHER, CHLOROFORM, AND OTHER ANÆSTHETIC AGENTS,

BY INHALATION,

IN

SURGICAL OPERATIONS,

INTENDED FOR MILITARY AND NAVAL SURGEONS, AND ALL WHO MAY BE EXPOSED TO SURGICAL OPERATIONS; WITH INSTRUCTIONS FOR THE PREPARATION OF ETHER AND CHLOROFORM, AND FOR TOWING THEM FOR INHALATION.

COMPRISING, ALSO,

A BRIEF HISTORY OF THE DISCOVERY OF ANÆSTHESIA.

BY CHAS. T JACKSON, M. D., F. G. S. P.,

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—*From the original*

TITLE-PAGE TO JACKSON'S BOOK

In which the details of the ether controversy are discussed.

the basis of oxygen want, the real importance of which we are just beginning to appreciate. Among the physicians who felt the spell of oxygen was Thomas Beddoes (1760–1808), of Shropshire, England, who founded in 1798 the Pneumatic Institute at Clifton for the treatment of disease by the inhalation of various gases. The institute failed, but the methods of Beddoes have had some vindication in the modern treatment of tuberculosis by the open-air method and of pneumonia by the administration of oxygen. The most important service rendered by Beddoes to medicine and science was his discovery of Sir Humphry Davy (1778–1829), who served as an assistant at the institute from 1798 to 1801. Davy was a great chemical genius, a poet, a philosopher and an indefatigable worker. His diligent researches on the effects of inhaling nitrous oxide overworked him, and from fatigue and overzealousness in these studies he more than once nearly died. At the institute, Davy was research director, or in the high-sounding phrase of the time, "superintendent of experiments."

Davy's researches on nitrous oxide were most complete and were conducted with much critical skill and ingenuity. He made care-

ful studies of the composition, analysis and properties of the gas, noted its physiological effects on animals, and then by means of an apparatus similar to a modern basal metabolism appliance, he studied its effects on humans. He observed that oxygen lack was of serious consequences, and one of his most famous conclusions was:

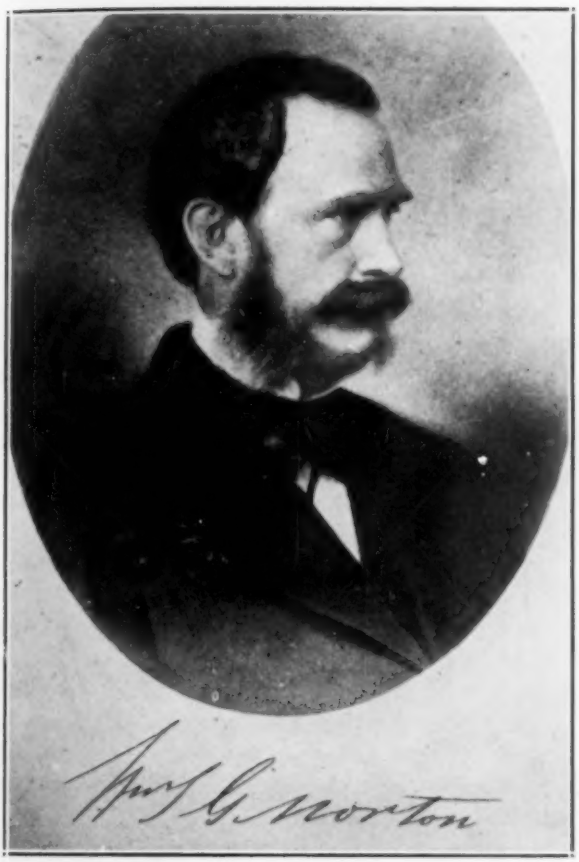
> As nitrous oxide in its extensive operation appears capable of destroying physical pain, it may probably be used to advantage during surgical operations in which no great effusion of blood takes place.

Davy attributed the effects of nitrous oxide to internal asphyxiation, since large amounts of carbon dioxide were exhaled after its use. Davy's researches became so well known that they were widely caricatured, the most interesting and famous of which efforts was the celebrated cartoon by Gilray.

The effect of the work of the Pneumatic Institute was to stimulate interest in volatile substances for the treatment of respiratory diseases. By the beginning of the nineteenth century, ether was in widespread general use as such an agent. From this use and from the popular lectures on the action of "laughing gas" or nitrous oxide there developed the custom of having "ether frolics," on which all the young people of a community would get intoxicated with ether while at some backwoods social function. These "ether jags" were very popular in the United States, and from them undoubtedly grew the realization of the anesthetic powers of the substance.

Many earnest experimenters noted the similarity of action between ether and nitrous oxide following inhalation. A note to this effect in 1818 is ascribed, without justifiable evidence, to Faraday. Among the earliest of the real experimental efforts to achieve definite surgical anesthesia were those of Henry Hill Hickman (1800–1829), who was a country practitioner in Shropshire, England. He worked both with carbon dioxide and nitrous oxide, but the ridicule he received at home and the failure of his demonstrations in France so discouraged him that he died in poverty while still a young man.

The story of the development of anesthesia now presents many interesting contrasts, from the calm satisfaction of what was considered modest achievement to the insanity and morbid ill-health occasioned by greed and disappointed egotism. The lives of Crawford W. Long (1815–1878), Horace Wells (1815–1848) and William T. G. Morton (1819–1868), all to be credited more or less with the discovery of real surgical anesthesia, are filled with such human and emotional appeal as to make the story of anesthesia one of the most interesting in the development of science.



—*From an engraving*

WILLIAM T. G. MORTON

Who demonstrated the anesthetic properties of ether.

Crawford W. Long studied medicine at the University of Pennsylvania, where now a graceful bronze medallion has been erected to his memory. It is stated that he was greatly impressed by the injunction of his professors never to publish any discovery in medicine until it had been fully verified by every means possible, in order to prevent the accumulation of useless medical literature. Long returned to Georgia, where he engaged in rural practice in the village of Jefferson. In the *Transactions* of the Georgia Medical and Surgical Association for June, 1853, Long describes how he first used ether for a surgical operation in 1842. He states that the people of the town had become interested in the exhilarating effects of nitrous oxide and asked him to prepare some for them. This he could not do, because he did not possess the required apparatus.

But he induced them to try ether as a substitute. Joining the "ether frolics" with them, he noted that often he would find bruises upon his body, the pain of which he had not felt while under the influence of the substance, and he noticed that his friends could receive under such conditions blows otherwise very painful. From this he was led to try ether in surgical operations. The first operation of which satisfactory evidence exists was on James Venable for the removal of a tumor on the back of his neck, performed on March 30, 1842, for which the enormous sum of $2.00 was charged. The ether was administered on a towel placed over the patient's nostrils, and the tumor removed without pain. This was repeated several times and mentioned to the physicians of the neighborhood. However, Long made no formal publication of his discovery until later.

Horace Wells was a dentist of Hartford, Connecticut, and was interested in the painless extraction of teeth. Witnessing a demonstration by Gardner Q. Colton on nitrous oxide, Wells noted that a person under its influence felt no pain. He asked Colton to administer the gas to him, and while under its influence had a tooth pulled without any painful sensation whatever. This was on December 11, 1844. In 1845, Wells went to Boston to arrange a demonstration of his discovery before the surgeons of the Massachusetts General Hospital. The inhaler used was apparently removed too soon, the patient gave a cry of pain, and Wells retired in shame under the rebuke of being called an imposter. He continued to give the gas in private, but brooding over his failure drove him insane and he committed suicide in 1848.

One of the witnesses of Wells's failure was William T. G. Morton, a dentist of Boston and a student in the Harvard Medical College. For some time he had been interested in the problem of alleviating pain in surgical operations, and by the failure of Wells was induced to give up the trial of nitrous oxide. He was at the time assisting in the office of Charles T. Jackson, a well-known physician, chemist and geologist of Boston. Jackson suggested that Morton try ether. This Morton did, experimenting first on animals in his own home, to the disgust of his wife, and then upon himself. His experiments convinced him that he had at last found what he desired. Application was made to the surgeons of the Massachusetts General Hospital for the privilege of making a demonstration, whether by Jackson or Morton has not been determined. Jackson, later, at any rate, claims that he sent Morton to give the demonstration as his substitute, since he was busy. The demonstration was arranged for October 16, 1846. Dr. John Collins Warren, internationally recognized as a surgeon of great ability, was to oper-

—*From a photograph*

OLIVER WENDELL HOLMES

Who suggested the terms "anesthesia," "anesthetic," etc.

ate. Morton did not come on time, and Warren made sarcastic references to his absence. When Morton did arrive in the amphitheater, crowded with his classmates and professors, Warren turned to him with the sharp rebuke, "Well, sir, your patient is ready." Morton had been detained by the completion of a new inhaler he had devised, but adjusting this to the patient, he quietly administered his as yet unknown agent, and turning to Warren replied, "Dr. Warren, *your* patient is ready." Warren operated in tense silence, the patient showing not the least indication of pain or movement. The operation, again, was for the removal of a tumor from the neck. When the operation was finished, Warren turned to the audience and said, "Gentlemen, *this* is no humbug."

The high character and international reputation of the surgeons

of the Massachusetts General Hospital assured the demonstration of complete success so far as publicity throughout the civilized world was concerned. This is an important point to keep in mind. Warren and Bigelow, the two most famous of the surgeons, were as much responsible almost as Morton for the rapid spread of the discovery of the relief from pain in surgical operations. Bigelow took ether with him to England and there performed the first operation with it on December 19, 1846, in London. Morton, in fact, behaved most reprehensively. He endeavored to keep his secret to himself, and with Jackson attempted to patent his substance on October 27, 1846. The substance was called "letheon," and an elaborate campaign was undertaken to introduce its use in a very commercialized manner in every city in the world. Surgeons were to receive exclusive rights to its use by the payment of huge royalties to the patentees. However, the scheme failed. It was impossible to disguise the fact that the substance was ether, and within a year surgeons all over the world were using it as a routine procedure in operations.

Much has been made over the fact that Long did not publish his discovery made in 1842. Morton did not publish his demonstration, either. It was done for him by the surgeons of the Massachusetts General Hospital. They made all the initial publications in the medical journals of this country (H. J. Bigelow, *Boston Medical and Surgical Journal,* November 18, 1846) and England, and Morton made no attempt to publish anything until 1850, when the chloroform controversy had arisen. Meanwhile, Jackson was sent out to make geological surveys of the shores of Lake Superior, and his interest in ether waned. Morton, however, in 1849, sought to have public recognition of his demonstration made by Congress, with a grant of $100,000. In the acrimonious debate which followed this proposal, the rival claims of Wells and Jackson as the discoverers of surgical anesthesia were brought forward by their friends. After five years of bitter wrangling, the friends of Long in Georgia appeared with evidence substantiating his claims. It is to Jackson's credit that he made a visit to Long in 1854 and was so thoroughly convinced of Long's priority in the discovery of the anesthetic powers of ether that he withdrew his own claims and made it impossible for any one else except Long to be considered. With characteristic modesty, Long refused public recognition and the controversy ceased. To the shame of science in this country, it was kept up by Jackson and Morton abroad, in the endeavor to secure honors and decorations from foreign governments and societies. In 1861 Jackson published "A Manual of Etherization," in which his story of the demonstration of the anesthetic is given.

—*From Gwathmey*

BUST OF SIR JAMES YOUNG SIMPSON

Who introduced chloroform as an anesthetic agent.

This was a well-written and calm statement, but it is evidence enough that greater modesty would have been more becoming all through to the author. Morton became increasingly agitated in his attempts to push his own claims for financial and honorable reward and died in 1868 in New York City from apoplexy induced by a fit of anger over Jackson's claims, while Long lived in peace and happiness till 1878.

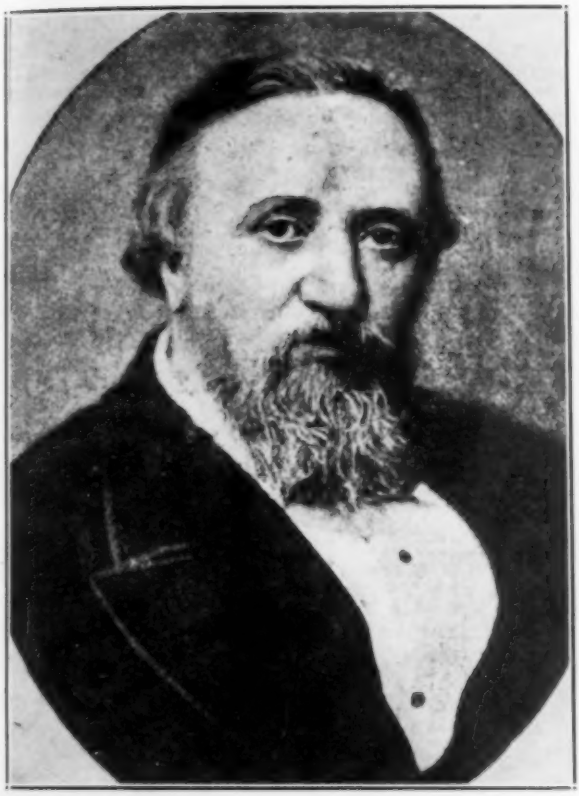
The use of the terms "anesthesia," "anesthetic" and "anesthetist," was due to the suggestions made by the distinguished scholar and poet, Oliver Wendell Holmes, professor of anatomy at Harvard, in a letter to Morton addressed on November 21, 1846. When a monument to the discoverer of ether anesthesia was proposed for Boston Commons, the question arose as to whose name should be inscribed thereon, Long's, Morton's or Jackson's. Holmes suggested, with characteristic wit, that the inscription read "To E(i)ther."

Among the first to use ether in England was J. Y. Simpson (1811–1870). He soon became dissatisfied with its irritating properties and with its odor. Upon the advice of Waldie, a chemist of Liverpool, Simpson tried chloroform as an anesthetic in his obstetrical practice. The French physiologist, Flourens (1794–1867), had noted on March 8, 1847, that chloroform had marked anesthetic powers on animals. Simpson found it entirely satisfactory, and on November 10, 1847, published his famous pamphlet on a "New anesthetic agent as a substitute for sulphuric ether in surgery and midwifery." As noted by Gwathmey, because of Simpson's writings and efforts in behalf of chloroform, its use spread with great rapidity and it soon almost completely supplanted that of ether.

Simpson's energetic support of chloroform brought on one of the most ridiculous struggles endured in the progress of science. The Scotch theological authorities opposed the use of chloroform for the relief of pain in childbirth on the ground that it was an impious interference with the will of the Lord. In early days, women had been burned alive in Scotland for attempting to secure relief from pain in child-bearing, and belief in the guilt of women and in the justice of their suffering was strong in the land. In spite of many well-written arguments on the part of Simpson in justification of his practice, he seemed about to fail, in Scotland, at least, when he won his point by as absurd an argument as can be imagined. He pointed out that in the 21st verse of the 2nd chapter of Genesis, the Lord Himself, in the first surgical operation of which we have record, before He took the rib from Adam's side to fashion Eve, caused a deep sleep to fall upon Adam, thus justifying the use of an anesthetic in surgical or obstetrical procedures.

Simpson's work in the introduction of chloroform was rewarded by his elevation to the peerage. It is related that Sir Walter Scott wrote to him on this occasion, suggesting as a coat-of-arms "a wee naked bane" (a small nude baby) with the motto beneath, "Does your mother know you're out?"

The scientific studies which placed the administration of ether and chloroform upon a sound rational basis were made by John Snow (1813–1858), who published in the year of his death his observations and researches. This work was carried on by his pupil, Sir Benjamin Ward Richardson (1828–1900), and by Joseph T. Clover (1825–1882). It was Clover who devised the inhalers which have proven so satisfactory for routine work. Richardson undertook an exhaustive study of all agents which might possibly have an anesthetic value. Among many others, he noted ethylene and methyl ether, both of which have been very recently resurrected for study. Richardson's work has unfortunately been buried in



—*From Scientific American Supplement, 1885*

SIR BENJAMIN WARD RICHARDSON

Who did pioneer scientific research in anesthesia.

out-of-the-way publications to which access is difficult. Richardson found ethylene an admirable general anesthetic, its only disadvantage being its gaseous state, which now is no disadvantage. Richardson was a genial scholar and wrote a delightful series of biographies entitled "The Disciples of Aesculapius." One of these essays is a charming appreciation of the life and work of his preceptor, John Snow.

Nitrous oxide, which had been eclipsed by the advent of ether and chloroform, was restored to a substantial position by the discovery of Edmund Andrews, of Chicago, that it should be administered with about 10 per cent. oxygen. Under these circumstances, it was found to be more satisfactory in many conditions than ether or chloroform. The report of Colton, made in 1867, on 20,000 successful cases had previously done much to restore interest in the gas.

A series of sudden and inexplicable deaths occurring under chloroform anesthesia soon made many surgeons very cautious in its use. In 1880, a special committee appointed by the British Medical Association condemned its use on the grounds of results obtained by a most exhaustive experimental study. This report was questioned, and a second commission, financed by the Nizam of Hyderabad, filed a report favorable to chloroform. A subsequent committee of the British Medical Association reported in 1891, after studying the records of 26,000 cases of operations under chloroform. It was concluded that no method of administration was free from danger, and the use of the substance, except in certain conditions, was strongly condemned. The most eminent physiologists of England were engaged in these studies, which were of great value in clearing up the mode of death under the action of chloroform. It was conclusively shown that blood pressure and respiration were greatly depressed and that often a reflex stoppage of the heart took place in the first few moments of anesthesia.

The administration of both ether and chloroform was greatly facilitated by the introduction of morphine premedication. This had been suggested by Claude Bernard in 1869 and was first applied by Crombil in Calcutta in 1881. Morphine, the chief alkaloid of opium, had been isolated by Sertuerner in Hamburg in 1806, and had been used to quiet patients and relieve pain before the demonstration of ether anesthesia.

Meanwhile, many sequences and combinations of anesthetic agents had been tried, but for routine operating the drop method of administering ether, almost like that practiced by Long in 1842, came into general vogue. Chloroform was found useful in war zones or near an open flame, while skilled anesthetists preferred nitrous oxide and oxygen. In 1915, George W. Crile, the distinguished surgeon of Cleveland, Ohio, began a careful study of the effects of anesthesia on the body, both with respect to the acid-base equilibrium and with respect to the effects upon the nerve cells. From these studies he was led to introduce a combination of local and general anesthesia termed "anoci-association." This did much to stimulate scientific interest in anesthetic agents and their action, and considerable work has recently appeared on the subject. Thanks to the efforts of Dr. D. D. Van Slyke and his coworkers, of New York, and to Dr. R. L. Stehle and Dr. Wesley Bourne, of Montreal, the mechanism of the production of ether acidosis seems to have been explained. It remains to be seen whether rational measures can now be taken to combat this acidotic effect of ether and chloroform.

The attempt has been made by Dr. Yandell Henderson and his associates at Yale to explain anesthetic shock on the basis of the

rapid removal of carbon-dioxide from the blood during the first few minutes of etherization when respiration is ordinarily greatly stimulated. While this theory has not received much support, it has resulted in the practical use of carbon-dioxide administered with oxygen for the purpose of rapidly removing an anesthetic gas from the body upon the completion of a surgical operation.

It is interesting to note that the greatest advances made in general anesthesia in modern times have originated in the United States and England. The French have been slow to accept either ether or chloroform, and for years used ethyl chloride, a highly toxic substance, following the suggestion of Flourens in 1847. In England and the United States attention to the problems of anesthesia has been maintained by associations of anesthetists, who meet frequently and discuss with enthusiasm the questions confronting them. In the United States these meetings have been promoted largely through the efforts of Dr. F. H. McMechan, of Ohio. In England, the publication of the *British Journal of Anesthesia*, to which Dr. Dudley Buxton is contributing valuable and interesting historical papers, will accomplish much in the interests of the speciality.

On March 17, 1923, Dr. Arno B. Luckhardt and Dr. J. B. Carter, of Chicago, published in the *Journal of the American Medical Association* their observations on the anesthetic properties of ethylene. This has been followed by many confirmatory reports, all of which seem to indicate that ethylene-oxygen anesthesia is destined to become of great and increasing importance. This work has aroused great interest in general anesthetic agents, and now reports are appearing from Dr. W. E. Brown, of Toronto, and Dr. J. T. Halsey, of New Orleans, on propylene, and from Dr. H. Wieland, in Germany, on acetylene. One of the most significant points emphasized by this recent work is the importance of oxygen in anesthetic conditions. An anesthetic agent is being sought which can be administered with so much oxygen that all deleterious effects incident to oxygen want can be reduced to a minimum. From other factors which enter, however, the ultimate solution of the problem of the ideal anesthetic agent seems to lie in the field of local anesthesia.

APPENDIX

Chronology of the Development of Anesthesia

2500 B.C. **Pressure on arteries and nerve trunks used for anesthetic purposes by Egyptians and Assyrians.**

1st Century A.D. **Dioscorides explicitly mentions use of mandragora locally and generally to remove pain during surgical operations.**

13th Century A.D. **"Spongia Somnifera."**

1530 **Paracelsus (1493–1541) introduces laudanum, and opium preparations begin to displace mandragora and belladonna.**

1540 Valerius Cordus (1515–1544) discovers ether (oleum dulce vitrioli).
1543 Ambrose Pare (1510–1590) discards spongia somnifera and uses pressure for anesthetic purposes.
1762 Anton Stoerck (1731–1803) critically investigates properties of stramonium, hyoscyamus and aconite.
1772 Joseph Priestley (1733–1804) discovers nitrous oxide.
1774 Thomas Percival (1740–1804) notes anesthetic action of carbon dioxide on raw wounds.
1790 Antoine-Laurent Lavoisier (1743–1794) explains oxidation.
1799 Humphry Davy (1788–1829) notes anesthetic properties of nitrous oxide.
1805 Ether inhalation quite generally used in phthisis and asthma.
1806 Friedrich Wilhelm Sertuerner isolates morphine and experiments on its physiological action.
1828 Henry H. Hickman (1800–1829) experiments on anesthetic action of carbon dioxide and nitrous oxide.
1831 Justus von Liebig (1803–1873) discovers chloroform.
1842 Crawford W. Long (1815–1878) uses ether as an anesthetic agent for surgical operations.
1844 Horace Wells (1815–1848) uses nitrous oxide as an anesthetic agent in dental operations.
1846 October 16, William T. G. Morton (1819–1868) demonstrates the use of ether as an anesthetic agent at the Massachusetts General Hospital.
1846 October 27, Morton and Charles T. Jackson try to patent letheon.
1846 November 18, Henry J. Bigelow's paper in *Boston Medical and Surgical Journal.*
1847 March 8, Marie-Jean-Pierre Flourens (1794–1867) notes anesthetic properties of chloroform and ethyl chloride.
1847 November 4, James Young Simpson (1811–1870) introduces chloroform into obstetrical practice as an anesthetic agent.
1853 Alexander Wood introduces hypodermic syringe.
1858 John Snow (1813–1858) puts administration of ether and chloroform on scientific basis by study of anesthetic concentrations.
1858 Albert Niemann in the laboratory of Friedrich Woehler (1800–1882) isolates cocaine.
1867 B. W. Richardson (1828–1900) introduces ether and ethyl chloride spray in effort to achieve satisfactory local anesthesia.
1868 Edward Andrews, of Chicago, puts nitrous oxide on safe anesthetic basis by administering oxygen with it.
1880 Chloroform condemned by committee of British Medical Association.
1881 Alexander Crombil, Calcutta Medical College, applies Claude Bernard's idea (1869) of pre-anesthetic medication with morphine.
1884 Carl Koller (1857–), Vienna ophthalmologist, discovers local anesthetic action of cocaine and applies it to eye surgery.
1885 James L. Corning (1861–) demonstrates hypodermic and spinal anesthesia with cocaine.
1889 Hyderabad Chloroform Commission amplifies B. M. A. committee report.
1893 British Society of Anesthetics formed.
1894 C. L. Schleich introduces infiltration anesthesia with cocaine.
1905 Alfred Einhorn and Braum discover and introduce novocain.
1915 George W. Crile (1864–) develops theory of anoci-association.
1922 Discussion of anesthetic shock, and study of effects of anesthesia.
1923 Revival of interest in ethylene and acetylene as anesthetic agents.

THE PROGRESS OF SCIENCE

By Dr. EDWIN E. SLOSSON

SCIENCE SERVICE, WASHINGTON

ARTIFICIAL GASOLINE

One of the most pressing problems of the present time is: What are we going to do when the oil runs out? If that question is not answered within the next ten or twenty years, the pressure on parking space will automatically be relieved through the growing scarcity of automobiles, aviation will remain a rarity and the small shop will tend to extinction through loss of its handy engine.

Already the question has become acute in countries less oily than ours. In England, Germany and France chemists are hard at work trying to invent ways of making something to match the natural petroleum that is still being so recklessly wasted with us. The three countries are pursuing different ways toward the solution of their common problem, and all have recently reported some measure of success in getting gasoline from coal.

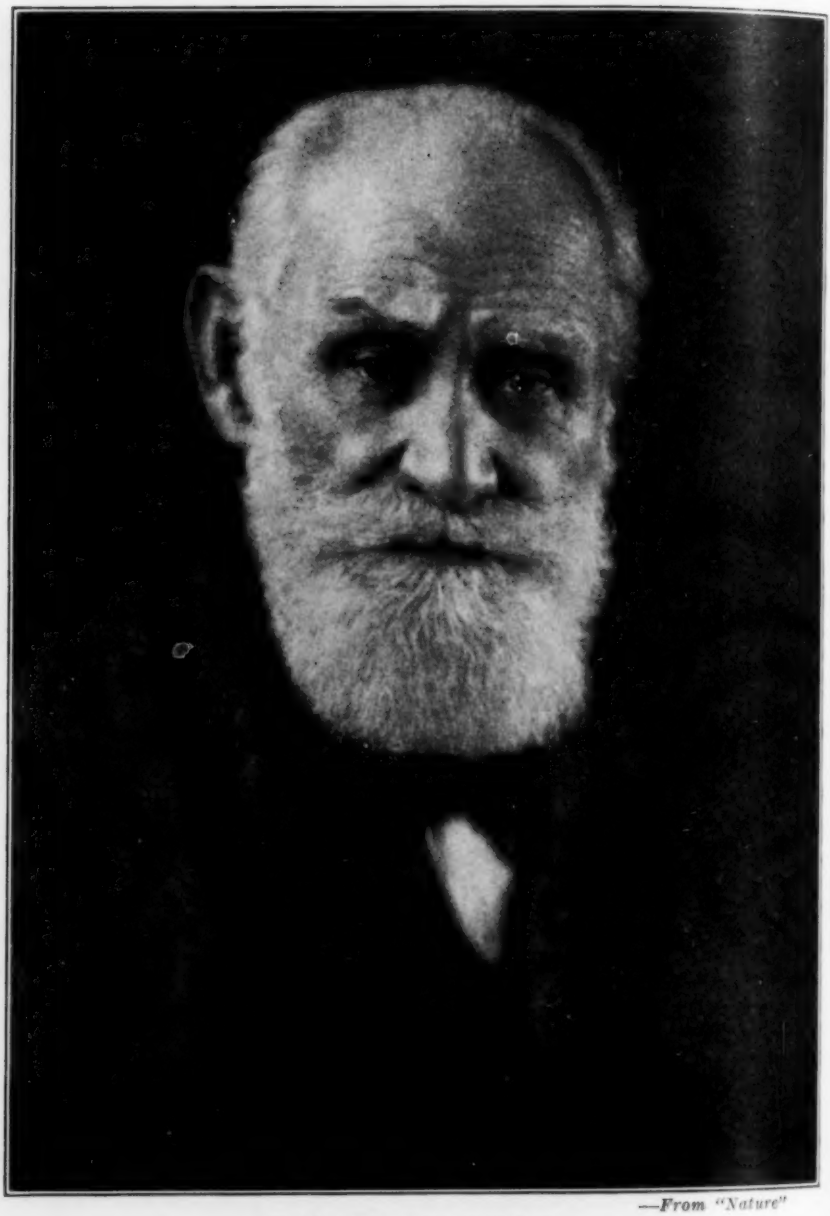
The British Department of Scientific and Industrial Research is experimenting in low temperature carbonization and has worked out a process that gives a gaseous fuel for local use, a liquid fuel suitable for motors and a solid smokeless fuel, which they call "coalite," for household and industrial purposes.

In Germany the Bergius process of treating powdered coal with hydrogen under high temperature and pressure is said to be capable of converting low-grade lignite into a synthetic petroleum equal to the natural.

In France, a Rumanian chemist, Georges Oliver, in collaboration with a French mining engineer, Charles Andry-Bourgeois, has invented a process claimed to be capable of converting coal, wood or any kind of carbonaceous material into gasoline of higher heating value than that obtained from petroleum. This is accomplished by the aid of certain catalysts which have the power of effecting the desired combination of carbon with hydrogen at high temperatures. Exactly what these catalysts consist of is not revealed in the account of the process given in the October issue of *La Science et La Vie,* but they are stated to be made of certain metallic powders spread upon infusorial earth, pumice, clay, charcoal and other porous bases.

The first stage of the process is similar to the familiar method of making coke and illuminating gas. The coal or lignite is mixed with from five to twenty-five per cent. of lime, soda or alumina and heated in tight retorts. The distillate of tar, ammonia and light oils is condensed and utilized. The coke remaining in the retort is converted into water-gas by the well-known method of passing steam over it while red hot. Water-gas is a mixture of hydrogen and carbon monoxide, both excellent combustibles and both employed in later parts of the process.

The gaseous output of the coke oven consists of free hydrogen, methane and more complex compounds of hydrogen and carbon. It is essential for the next step that there should be an excess of hydrogen. If the mixed gas contains less than fifteen or twenty per cent. of hydrogen by weight more must be added. This additional hydrogen may be obtained from



—*From "Nature"*

IVAN PETROVIC PAWLOW

The distinguished Russian physiologist who recently celebrated his seventy-fifth birthday.

the water-gas or, if necessary, by decomposing water by the electric current.

The second stage of the process consists in passing these gases through an electrical furnace heated to 3,000 degrees centigrade. This transforms the methane into acetylene and changes the other hydrocarbons into forms more active and ready for combination.

The gaseous mixture so obtained is next conducted under pressure through tubes containing the catalyzing agents. The temperature at the beginning of this, the third stage of the process, is about 150 degrees centigrade at first, but rises to 400 degrees at the end. Contact of the gases with these finely divided metals somehow causes the smaller molecules to hook up together and form larger molecules, and the colorless gas that entered the tube comes out as a colored oil, which, like the distillate of natural petroleum, looks red by transmitted light and green by reflected light. It contains about 75 per cent. of very light gasoline.

In the fourth and final stage this colored oil is again passed over metallic catalyzers with an excess of hydrogen at a temperature of 180 degrees. The finished product is a light limpid colorless liquid having a very agreeable odor. It consists largely of what the chemist calls the "hydrogenated compounds of the benzene series," such as cyclohexane. In composition it consists of about 86 per cent. of carbon, 13.5 per cent. of hydrogen, with very little oxygen and less sulfur.

The process seems pretty complicated, but according to figures of M. Olivier gasoline can be manufactured from the French lignites at a cost of twelve cents a gallon, which is less than a third the present price of gasoline in France. The initial plant constructed at Asnieres is expected to turn out a thousand tons a day. Twenty-five per cent. of the carbon in the original coal comes out in the form of gasoline. The rest is mostly employed in heating the gas and apparatus and running the engines.

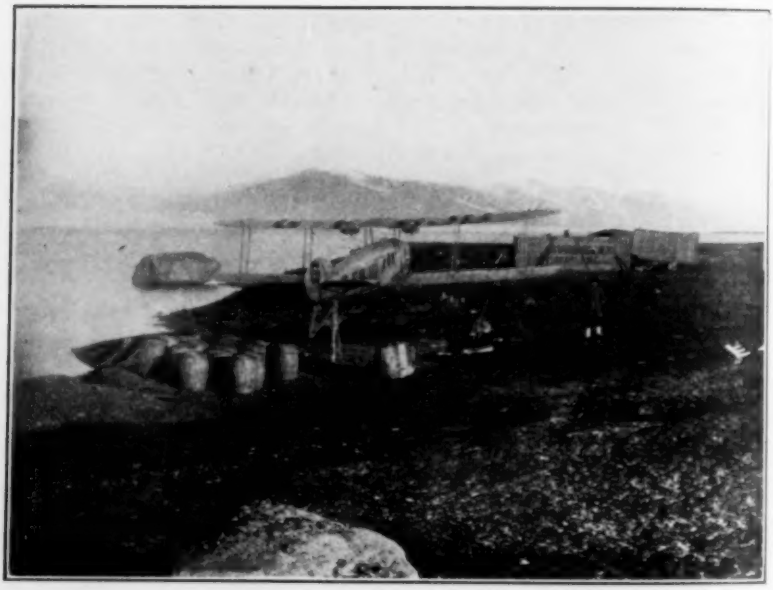
STARTING A NEW DISEASE

We would suppose that there were diseases enough in the world so that no one would rejoice over a new one. Yet few of the thousand papers read before the recent session of the American Association for the Advancement of Science aroused more enthusiasm than that in which Dr. James Johnson, of the University of Wisconsin, told how he had started a novel malady in tobacco and tomato plants by inoculating them with the juice of healthy potato vines. The diseased plants may in turn infect other plants of the same or other sort and so on indefinitely, the virulence of the virus increasing with each stage.

It seems that what is one plant's food is another plant's poison and that the wholesome sap of the harmless necessary tuber may induce a fatal infection of the weed whose poisonous nature we were warned against in childhood.

The disease is first manifested as a faint mottling of the larger leaves of the young plants, but after passing through two or more generations of tobacco it becomes intensified and causes dead spots or blotches. It belongs therefore to the class called "mosaic diseases," not in reference to the Mosaic law but because they are commonly recognizable by scattered white patches that make the leaf look like a cross-word puzzle, only there isn't any answer to it, or at least the biologists have not yet found the answer.

They do not even know whether the virus of the mosaic diseases belongs to them or to the chemists. It seems to stand somewhere between the two



THE OXFORD UNIVERSITY ARCTIC EXPEDITION

On and near the Polar island of North Eastland, the survey as has been concluded from the air and about its coasts with two ships and motor boat. Wireless is extensively used in these operations, the seaplane and ships being in touch, while sledges equipped with radio installations are also used.

sciences, between the animate and inanimate kingdoms, if there is such an intermediate state. There are dozens of different mosaic diseases known in the plant world, as definite and distinguishable by habit, host and symptoms as are smallpox and measles. The active agency, whatever it may be, can multiply indefinitely and infect in succession any number of other plants in the vicinity to which the virus may be carried by sucking insects, as mosquitoes or fleas carry malaria or plague. From this we should naturally infer that a mosaic disease is due to a minute living organism, a microbe.

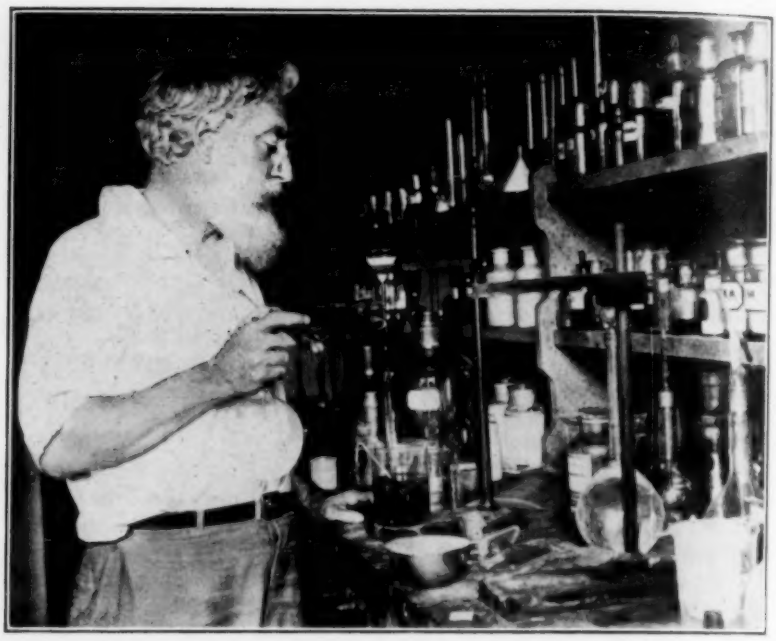
But this appears impossible because of their extreme minuteness. They can not be discerned with the most powerful microscope. They pass through the pores of a collodion membrane or a filter of unglazed porcelain, such as is supposed to take out every solid and suspended particle and pass only pure water and the salts dissolved in it. This would make them out so small that it would take some forty or fifty thousand of them, side by side, to measure up to a millimeter, or some three thousand of them to be as thick as this sheet of paper.

"But," says the chemist, "such a minute mass would be a mere structureless sphere. It is smaller than a molecule of protoplasm and could not possibly contain all the machinery essential for a living creature and its descendants. Besides, molecules don't breed."

"But don't they?" retorts the biologist. At least Dr. Johnson suggests as a possible solution of the mosaic problem that the ultimate molecule or particle of the virus may be capable of reproducing itself when transplanted into the favorable environment of the living cells of the host plant. Another suggestion is that the virus injected into the cell may stimulate this to production of some substance, injurious to itself, which in turn is capable of setting up a similar stimulus in other cells. There is a third possibility, that is, that the apparently healthy potato was a carrier to the virus of tobacco plant as certain people, without harm to themselves, will harbor and distribute the typhoid germ. But this last theory is highly improbable, for Dr. Johnson used extracts from fifty different potato vines, the best to be found on the farm, and got infections of tobacco from them in every case. He tried inoculating tobacco with forty species of plants other than potato but failed to get any symptoms of disease.

So it seems that there must be something in the cell sap of the potato that starts a self-perpetuating disturbance of some sort in plants of the same family. But the susceptibility appears to be confined to the Solanums, so nobody need fear the potato unless he belongs to the family. Nor do any of the mosaic diseases attack human beings. I mention this lest the reader should get a prejudice against the potato and leave it out of his dietary for fear of getting a spotted skin.

The Solanum family has suffered from a bad reputation, perhaps because it comprises such unwholesome plants as belladonna, henbane and jimson weed. Potato, tomato and tobacco when they were introduced into Europe a few hundred years ago met with furious opposition. They were all three accused of being injurious to both health and morals. But the potato and tomato are now welcomed to the most exclusive tables and the tobacco is welcomed at all tables except the most exclusive.



DR. HENRY S. WASHINGTON

of the Carnegie Institution of Washington, who is making a series of chemical analyses of the lavas of the volcanoes of the Hawaiian Islands.

THE AFRICAN MANLIKE APE SKULL

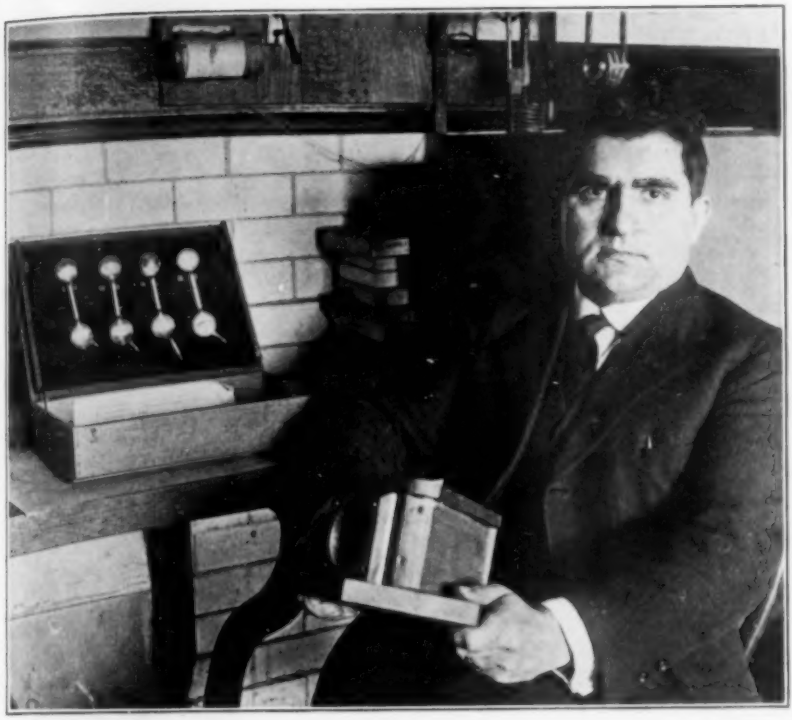
By Professor Raymond A. Dart, of Witwatersrand University, South Africa

The skeletal remains of Australopithecus Africanus consist of two fragments. One is an endocranial brain cast (the form of the interior of the cranium) and this is complete and whole. The other is the face of the skull which was found completely imbedded in the limestone of an old cavern. This ancient cave was completely filled with bedded sand infiltrated with lime.

The site of the discovery is near the locality of Taungs, Kalahari, Bechuanaland and the cave is in the Kaap Plateau composed of dolomitic rocks.

The skull is dolichocephalic (long and narrow and somewhat oblong in shape). The face is leptoprosopic (relatively long and narrow).

The remains are those of a juvenile subject with the first permanent molars erupted. The brain has a size just slightly larger than that of an adult chimpanzee. The sulcus lunatus (the lunar fissure, one of the convolutions of the brain) shows a position approaching the same feature in the human being. The brain shows marked temporo-parieto-occipital expansion (enlargement of the posterior or back two thirds of the cerebrum). There is an absence of the pre-rolandic and post-rolandic flattening of the skull. (That is, the muscles of the jaw at the stage of evolution shown by



DR. C. C. KIESS

Of the United States Bureau of Standards, with the apparatus he used on board the dirigible *Los Angeles* to photograph the eclipse of the sun on January 24.

the skull had decreased in size due to lack of hard usage so as to allow the brain in the region of the temples to bulge out. This is a human-like characteristic.)

The ridges above the eye orbits of the skull are absent (unlike those in apes). The eye orbits are rounded. The nasal or nose bones terminate above the line connecting the lower margins of the eye orbits. (This is human-like.) The upper dental arch is parabolic in shape (this type of setting for the teeth is more nearly human than that of the apes). The canine teeth are small and their diastema (the space between the canine and front teeth) is three millimeters. There is no diastema or space in front of the canine teeth of the lower jaw. This lower jaw resembles in its front portion the famous Heidelberg jaw.

Another point of importance showing the jaw's close approach to human characteristics is the lack of a simian shelf, a ledge on the interior of the lower jaw present in the apes. The canines of the jaws are small and lie in line with the slightly crowded vertical incisors or front teeth.

The foramen magnum (hole through which the spinal cord enters the brain) is placed well forward. (In the monkeys this is well to the rear of the skull and its location in the newly found skull indicates that the creature to whom it belonged may have walked upright.)

The specimens are diagnosed as those of a manlike or anthropoid ape, and classified as a new family, the Homosimiidae.

That the skull of the anthropoid ape child found by Professor Dart in Africa is an important link in the ancestry of man is the opinion of Dr. Aleš Hrdlička, anthropologist of the Smithsonian Institution, after he had read and studied the article sent by Professor Dart to *Science Service*.

The remains of this four-year-old child, just beginning to cut its first permanent teeth, will probably take their place beside Pithecanthropus, Piltdown man and the other famous relics of man's evolution and antiquity. Buried as they were deep in limestone, Dr. Hrdlička believes it probable that they date from Tertiary times, a time more ancient than any in which human remains have heretofore been found. In this case they have been preserved for hundreds of thousands of years.

The fact that the skull was so young when its owner met death is a disadvantage from the standpoint of anthropological study, for the skull of a young ape has more human characteristics than the skull of an adult ape.

Yet there seems to be little doubt but that there has been discovered on the reputed "dark" continent a most important step in the evolutionary history of man who arose from the same stock as the present apes. Australopithecus Africanus is probably more remote in human ancestry than Pithecanthropus, the ape man of Java, up to now considered the oldest manlike creature known to science.

Australopithecus was not an ape-man like Pithecanthropus, but a man-ape. He was a creature who emerged just before the dawn of man. He is one of those beings popularly known as a "missing link," intermediate forms having both human and ape-like characteristics.

Australopithecus may be related to America through two lines, that of man and monkey. The descendants of Australopithecus through evolutionary processes may have become modern man. His ancestors evolving in a different direction may also have given rise to the kind of monkeys that now inhabits South America.

Dr. Hrdlička believes that the new African man-ape is more closely related to the old African stem of the American monkey than to the type of monkey now living in the old world. It is generally conceded that the American type of monkey came from Africa in Tertiary times when there was a land bridge between Africa and South America. In characteristics, Australopithecus resembles the American type of monkey more closely than the African.